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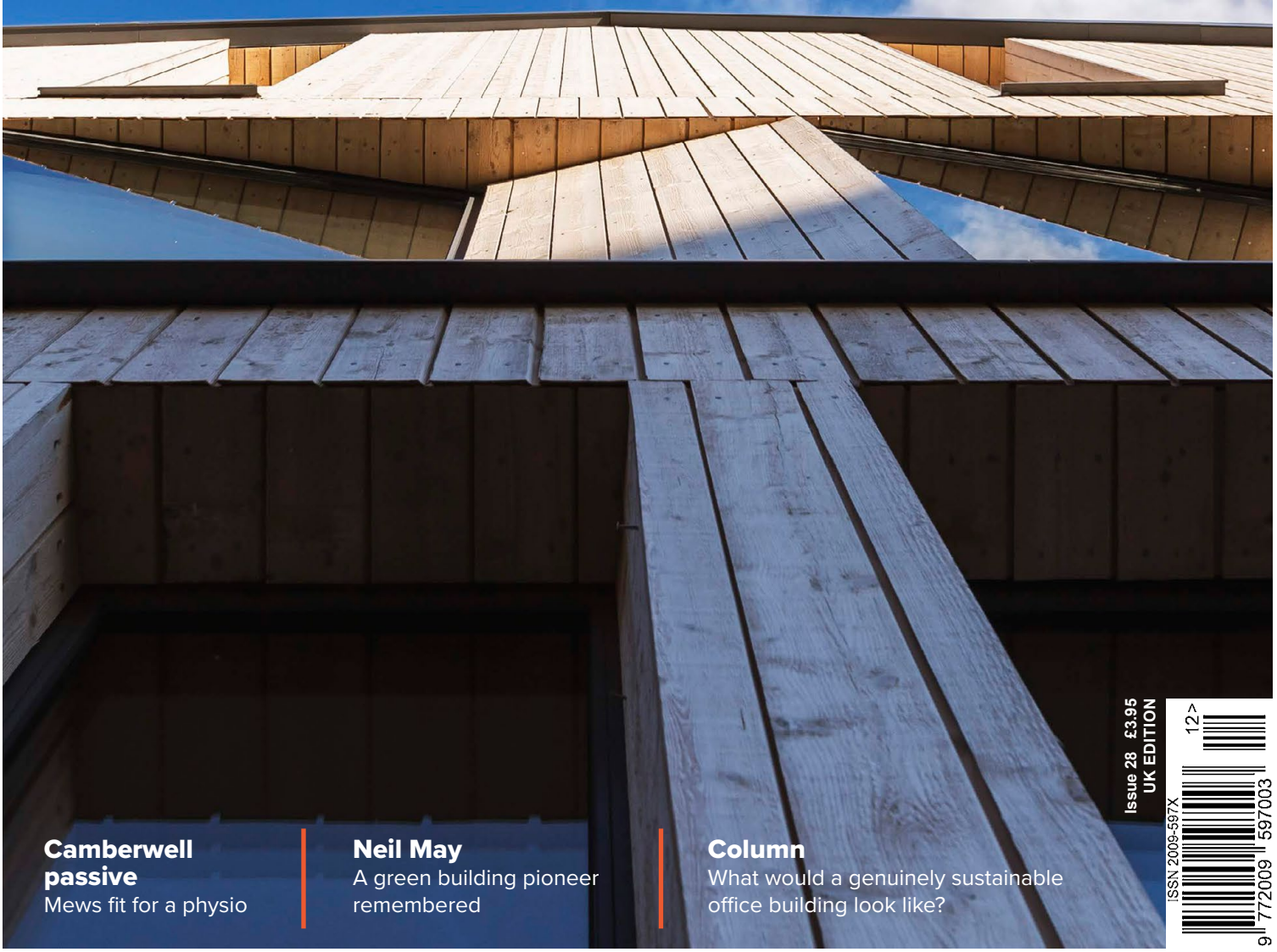

Camberwell passive
Mews fit for a physio

Neil May
A green building pioneer remembered

Column
What would a genuinely sustainable office building look like?

Issue 28 £3.95 UK EDITION

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going passive need not limit your design

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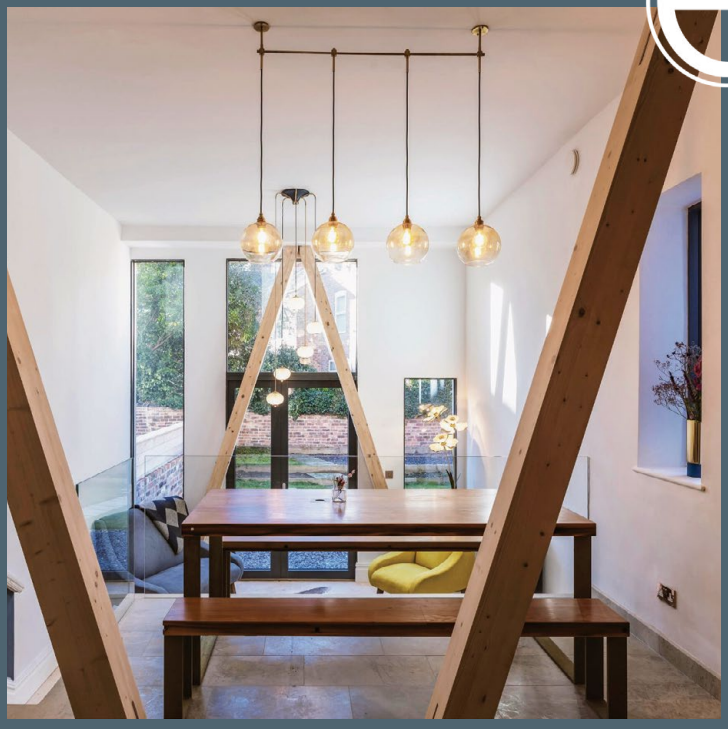
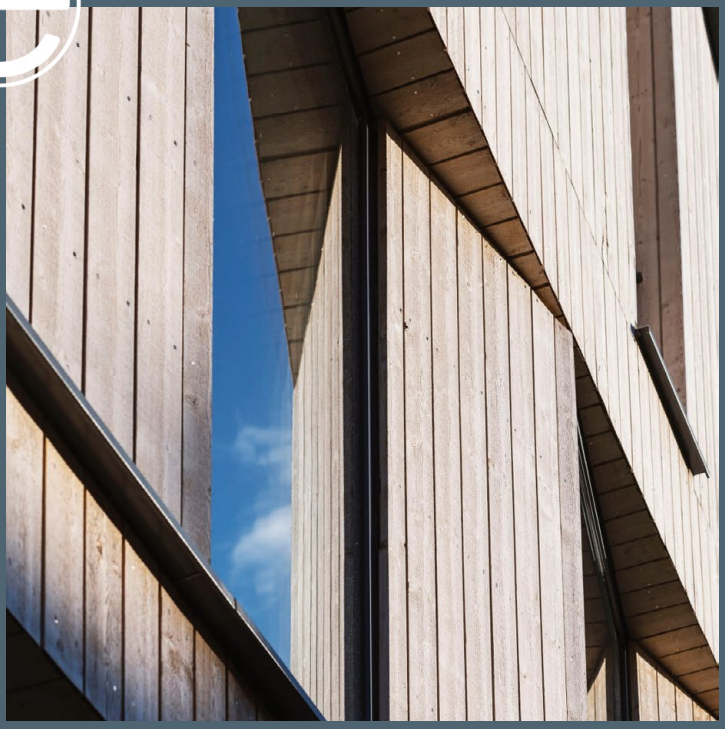
Passive House Institute





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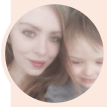
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Houses on Zetland Road, Ecospheric
Photo by Rick McCullagh

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editor's letter

ISSUE 28

Half a lifetime ago, an errant friend of mine made a habit of arriving home after an evening's over-exuberance, only to have the penny drop that he'd forgotten his house keys. He had no option other than to scale a back wall and contort his inebriated body through the narrowest of bathroom top light windows to get in. He repeated this trick more often than he'd care to remember - to the extent that he could remember. In the early years it was second nature to him: he was the proverbial whippet. But as the years went by, on the occasions - rare as they were becoming - when he had to repeat his contortionism, he told me it had become much trickier. The window seemed to be getting smaller.

There may be more elegant metaphors for humanity's climate crisis, but this one seems apposite. Carried away in our excesses, failing to plan ahead, we now find ourselves trying to contort our bloated selves to safety, with only a tiny - and in this case literally shrinking - window to contort ourselves through. If we fail, we'll be exposed to whatever the elements throw at us.

In our case, the shrinking window that faces us was once a proverbial bi-folding door. It's over 30 years since James Hansen first brought global attention to global warming via providing evidence to the US Congress at a time when Washington paid more attention to little things like facts, evidence & the considered theories and analyses of its own experts. It's over 21 years since the international community agreed to control and cut emissions under the Kyoto Protocol. And yet what have we done? 2018 is on course to be a record-breaking year for CO2 emissions - a 2.7% increase on 2017, and an incomprehensibly large total of circa 27 billion tones. Then there's the slew of recent evidence of mass species extinction - some of it linked to climate change, or to other environmental destruction humanity has wrought on the world. Or the evidence that our own lifespans risk being cut short by a heady cocktail of toxic air & water, resistant strains of bacteria developing from overuse and misuse of antibiotics (including antibacterial products), the collapse of food chains, etc.

But we must not despair. It is incumbent upon us to carefully consider the evidence and start making the changes we need to make - personally, within our communities and on a societal level - to rapidly effect change. The last few years seem to have been hijacked by populist lurches on either side of the Atlantic. And as all-consuming and worrying as the potential fallout of the likes of Brexit & Trump may be to this particular snowflake, I'm left with an abiding feeling that they'll ultimately look like a distraction. That unless we act quickly & decisively, we may find we're not so much rearranging the deckchairs on the Titanic, but voting to elect a new captain & officers for the sinking ship.

I hope you find inspiration for the kinds of meaningful actions we can take to tackle our current existence-scale crisis from some of the extraordinary buildings published in this latest issue, and from the combination of client-drive, design & construction ingenuity, & material & technological innovation on display.

Regards,
The editor

AECB building knowledge

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Passivhaus Trust The UK Passive House Organisation

About
Passive House Plus is an official partner magazine of The Association for Environment Conscious Building, The International Passive House Assocation and The Passivhaus Trust.

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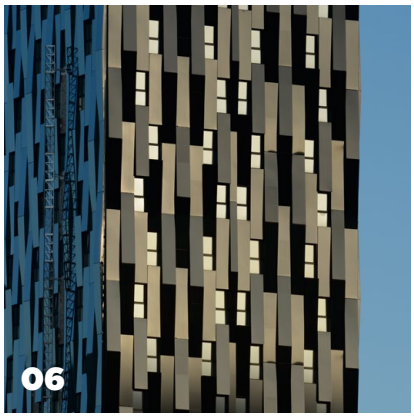

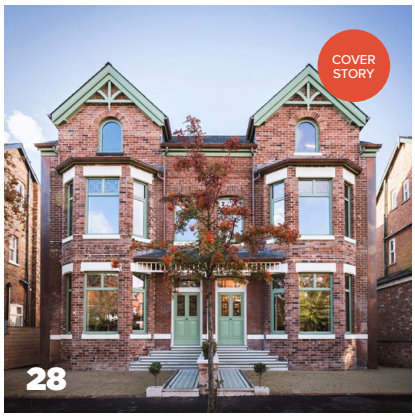

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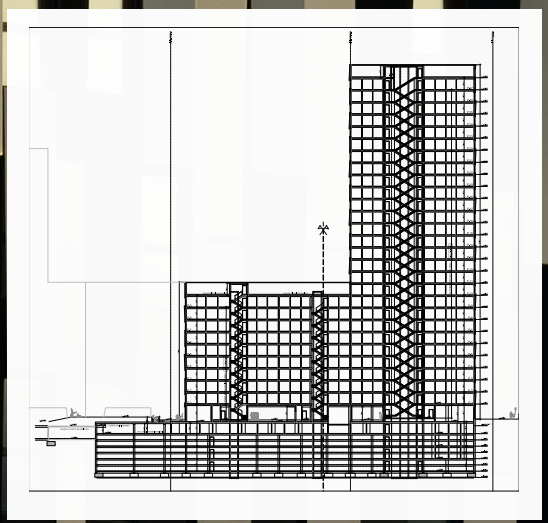
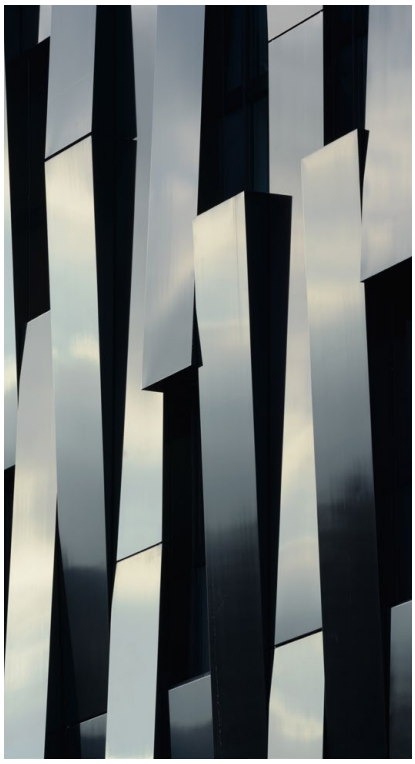
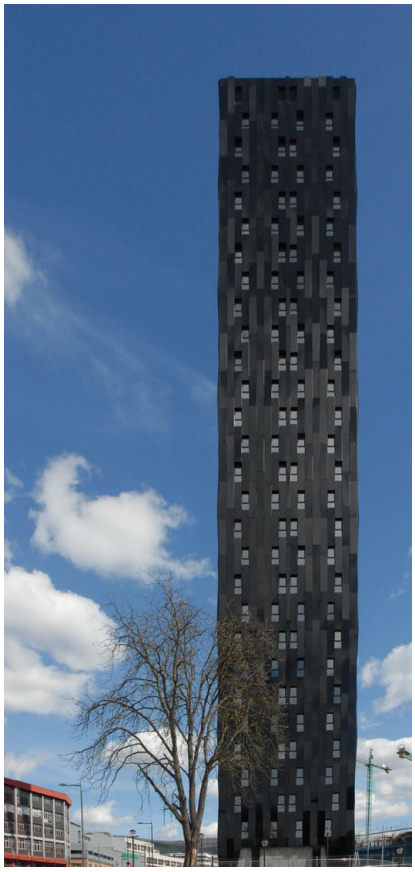


Photos: Várquitectos

INTERNATIONAL

A SELECTION OF PASSIVE & ECO BUILDS FROM AROUND THE WORLD





BOLUETA BUILDING, BILBAO, SPAIN

At 28 storeys tall and rising to a height of 88 metres, the Bolueta building in the Spanish city of Bilbao is now the tallest building in the world certified to the passive house standard. Developed by the Basque government's own property development firm Visesa, it will soon be accompanied by a second 21-storey passive block, with the two buildings containing 361 social housing units.

But the project had a rocky start. Back in 2012, architects VArquitectos won a competition to design the project. It was intended to be energy efficient from the get-go — but not necessarily passive house standard — and to draw heat from the local district heating network. But when the network supplier went bust, Visesa decided it needed an even more efficient building.

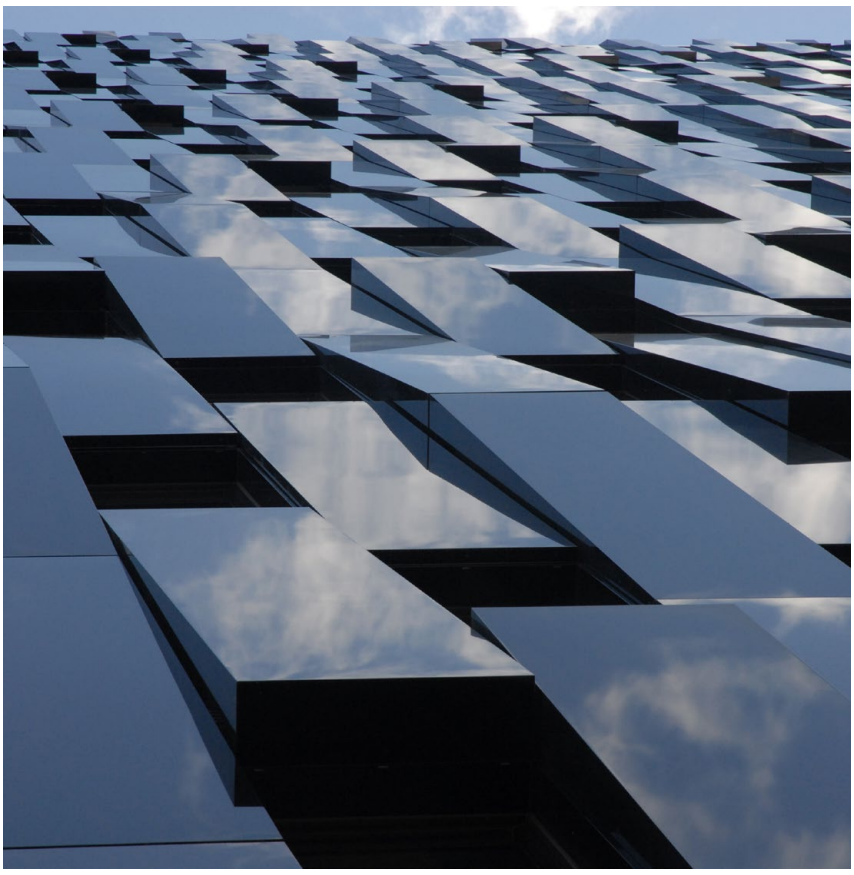
VArquitectos and energy consultant Energiehaus started to examine the possibility of adopting the passive house standard, and found that the optimum geometry, low surface-to-volume ratio and the warm local climate all made it ideally suited. So, the team set about beefing up the energy efficiency spec.

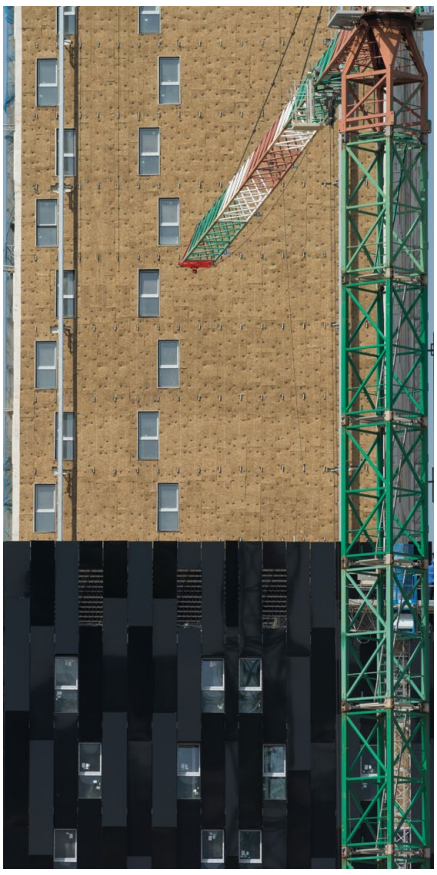
The finished building is constructed from steel-and-masonry, with mineral wool insulation to both the outside (10cm) and inside (5cm). The designers swapped out the double glazing for triple glazing when re-designing the project. and introduced heat recovery ventilation. All units in the building were made individually airtight and achieved an air test result of between 0.28 and 0.35 air changes per hour — about half the maximum 0.6 allowed under the passive house standard, an exceptional achievement.

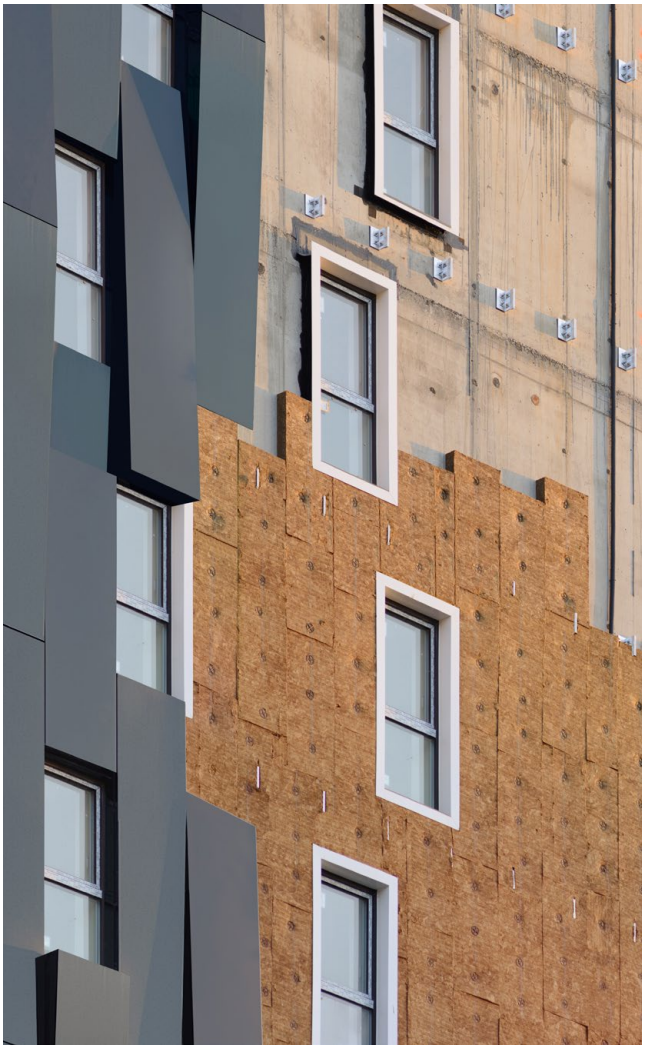
The shining external finish, meanwhile, is a ventilated aluminium cladding. "The black colour symbolises the industrial past of the city," says architect Germán Velázquez of the practice VArquitectos. "It is a tribute to the two-and-a-half century old heavily coal-based industry." The second tower, meanwhile will be grey in colour to allude to the steel industry once prominent in the city.

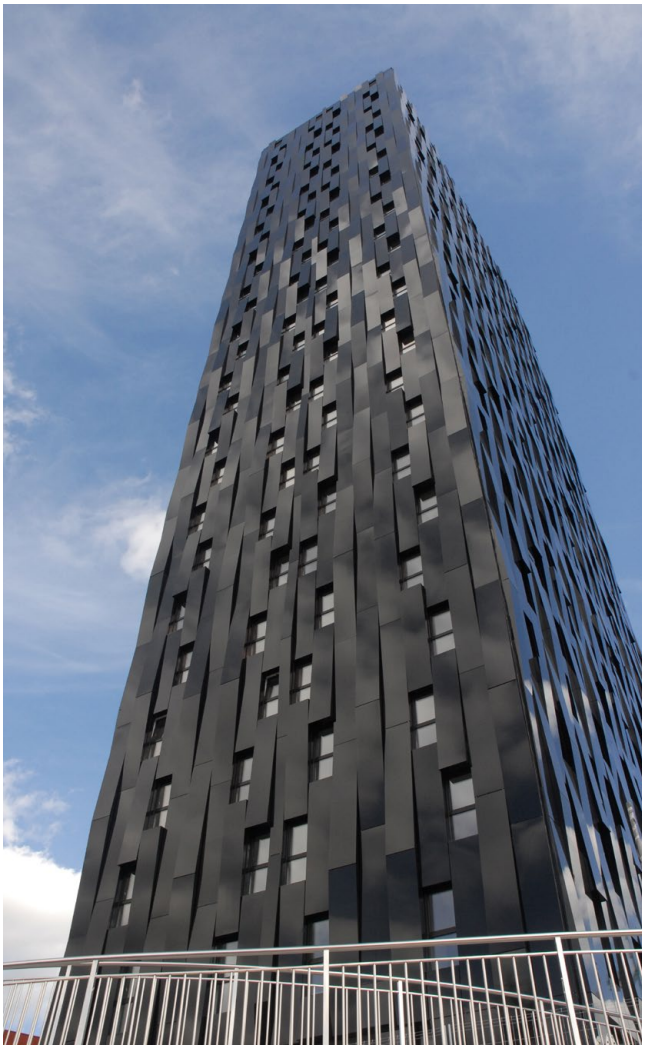
The architects estimate that all the improvements over the initial project increased the capital cost of the project by about 3%, while cutting energy bills in half and improving comfort and air quality.

"Now that Bolueta is complete, there are no excuses anymore," says Velázquez. "It is possible to realise such a project in Bolueta, and it is just as possible to realise one almost anywhere."

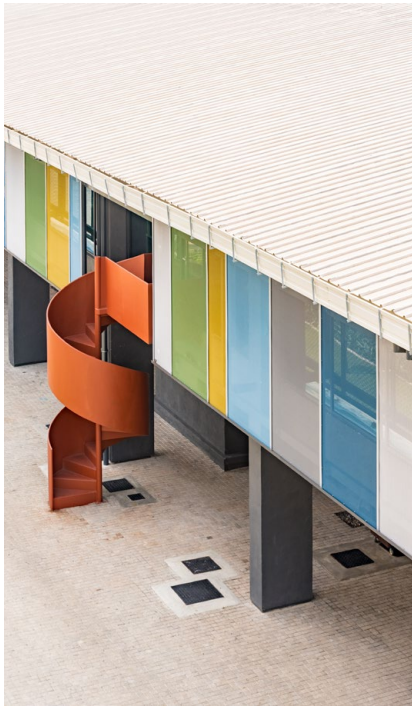








Photos: Jordan Parnass Digital Architecture



STAR GARMENT INNOVATION CENTRE, SRI LANKA

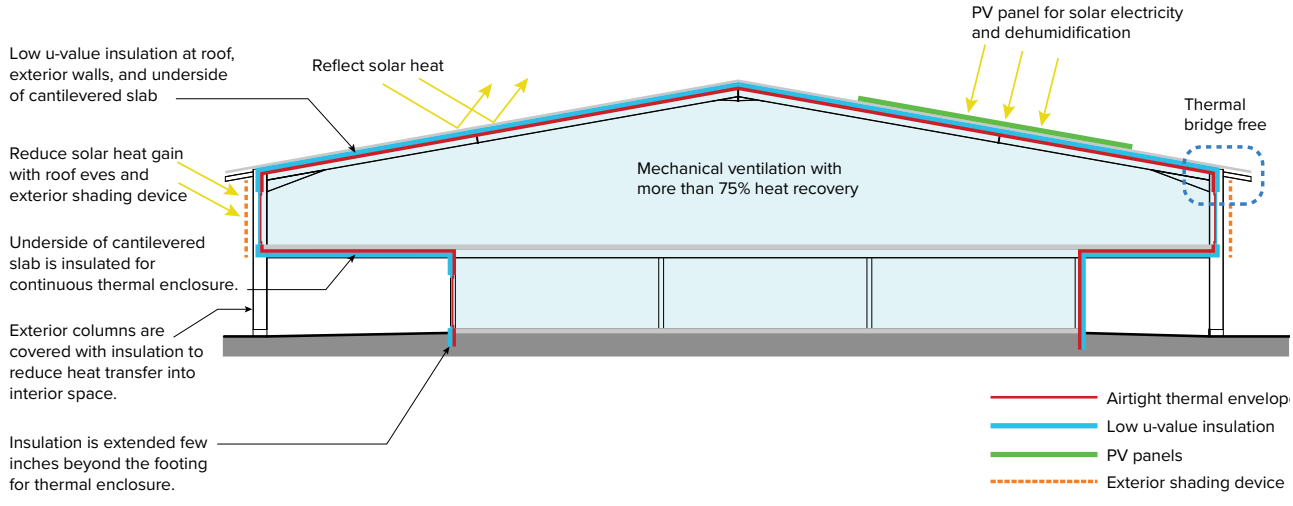
This new clothing factory in Colombo, Sri Lanka is the first passive house project in South Asia and, located just above the equator, it posed vastly different climatic challenges than your average European passive house designer is used to — think tropical monsoons, year-round heat, and extremely high relative humidity.

Developed by the Star Garment Group — a global apparel sourcing, design and manufacturing firm — the building serves as the company's new product development centre, a hub for design, material sourcing, pattern making and sowing. And according to its designers, Jordan Parnass Digital Architecture, it "sets a new high bar for sustainability, energy efficiency and worker comfort" in the garment industry.

Rather than build entirely from scratch, the project team opted to retrofit an old factory on the site, stripping it back down to the original steel frame and concrete slab, thus reusing elements that would otherwise have significantly increased a new building's carbon footprint.

The original steel frame was filled in with a new thermal envelope comprised of high performance curtain walling, externally-insulated masonry and insulated metal roofing panels — all of it made airtight. Given its tropical location the building has zero heating load, but instead requires mechanical cooling and dehumidification. There are also strategically designed overhangs and external shading screens to help keep the sun out.

The project was recently certified to the Enerphit standard, the Passive House Institute's benchmark for retrofit projects. "By promoting the project's goals and inspiring the local building industry, JPDA has sought to establish a clear path to both reducing global carbon emissions and putting an end to worker 'sweatshop' conditions," say the architects. ▶


Low u-value insulation at roof, exterior walls, and underside of cantilevered slab
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Airtight thermal envelop
Low u-value insulation
PV panels
Exterior shading device

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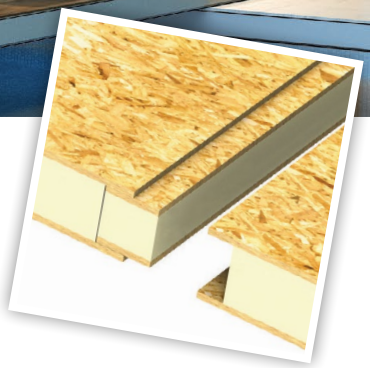

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NEWS

Herefordshire eco-cottage wins Passivhaus Award

Old Holloway Cottage, the 100 square metre timber-and-straw cottage in rural Herefordshire that was designed by its homeowner, architect Juraj Micurcik, picked up the small project award at this year's UK Passivhaus Awards, which were presented at the end of October. The project featured on the cover of issue 27 of Passive House Plus.

Meanwhile Carrowbreck Meadow, a mixed social and private scheme of 14 homes in Norfolk with a design inspired by the county's vernacular barns, won in the category for large residential projects. The Enterprise Centre at the University of East Anglia, designed by Architype and described by some as the UK's greenest building, won in the category for non-domestic projects.

In the new people's choice category, voted for online by the public, the George Davies Centre for Medical Studies at University of Leicester picked up the award.

All the projects are passive house certified, and all have been profiled previously in Passive House Plus. The awards were sponsored by Ecology Building Society, Munster Joinery and Ashden. ■

2018 UK Passivhaus Awards winners included (clockwise from top left) Old Holloway Cottage; Carrowbreck Meadow; The Enterprise Centre at the University of East Anglia; and the George Davies Centre for Medical Studies at University of Leicester.

Buildings regulations set for major overhaul

Review to look at Part L & Part F, which deal with energy efficiency & ventilation

Words by Kate de Selincourt

Minimum targets for primary energy use in buildings, and a mandatory overheating standard for homes, are under consideration in a review of the UK building regulations expected in the spring. Part F (ventilation) as well as Part L (heat and fuel) will be updated.

The moves have been broadly welcomed, though passive house designers and the Association for Environment Conscious Building (AECB) are urging the Ministry of Housing, Communities & Local Government not to over-complicate the regulations, and to ensure that better use is made of existing skills and knowledge, in order to get the basics right first.

Peter Rankin, an official in the Ministry of Housing, said in November at an event organised by the Chartered Institute of Building Services Engineers (CIBSE) that the government believes it is time to set primary energy targets for buildings, and that the ministry will also be looking at an overheating standard for homes.

Passive house designer and certifier Sally Godber said she and her colleagues at leading passive house consultancy Warm "strongly support" a move toward metrics that minimise heat demand per square metre of floor area in buildings.

"An absolute metric pushes designers to develop naturally efficient shapes and glazing – which in turn is likely to benefit summer comfort," she said.

The proposals are also welcomed by construction bodies CIBSE and the AECB. However, commenting on Peter Rankin's claim that "we will use new technologies to halve the energy use of new buildings by 2030," AECB chief executive Andy Simmonds pointed out that, "we don't need new technologies to do this".

"Simply designing and building to well-tried standards such as the AECB Building Standard and passive house easily achieves this goal," he said.

CIBSE agrees that there is an urgent need to close the performance gap — the difference between the amount of energy buildings are designed to use, and what they use in practice — and for greatly strengthened enforcement of building standards, in line with the recommendations of the Hackitt report (see overleaf). After starting a joint consultation process with stakeholders including the London Energy Transition Initiative, CIBSE says there is consensus that Part L must more closely reflect what actually happens in occupied buildings. CIBSE technical manager Julie Godefroy told Passive House Plus that there was strong support for requiring monitoring and reporting, with the possibility of moving towards regulation of the actual performance of completed buildings or developments.

CIBSE also reports wide agreement for Part L to introduce absolute energy metrics. In relation to overheating, many consultees agreed with CIBSE's view that dynamic simulation modelling should be the ultimate test of summer comfort, if a design did not pass a preliminary assessment. Sally Godber and some fellow passive house designers however are less sure.

Citing the example of the London South Bank University study in Camden, which reported temperatures of 47.5C during a heatwave in an apartment building modelled to have much lower temperatures, (see Passive House Plus issue 26) Godber warned of concerns about the accuracy of modelling results, in the absence of an industry scheme to ensure competency of modellers: "Dynamic modelling hasn't been proven in accurately modelling how buildings behave. It is also complex and hard to check and cannot easily be used as a design tool."

Passive House designer Alan Clarke added the warning that all models (including PHPP) could be gamed. He called for the inclusion of some 'first principles" checks – including a realistic assessment of internal heat gains, particularly from building services, like heating systems.

"Neither controlling gains nor provision for natural cooling are sufficient on their own," he said. "There should be a check to establish each is adequate."

CIBSE agrees with many in the passive house world that Part F (ventilation) needs an overhaul, as well as Part L. The regs currently contain few guidelines relating to indoor quality, and those there are, are poorly implemented.

While CIBSE's focus is on excluding outdoor air pollution, and setting indoor air quality targets, Sally Godber and Alan Clarke stressed the need to address installation and commissioning – even to the existing standards.

Alan Clarke also pointed to the fact that many voices are calling for 'System 1' ventilation (trickle vents plus intermittent extract fans) to be removed from the regulations. "In practice system 1 doesn't really meet the regs, as it is not an adequate means of ventilation. Intermittent extract fans are clearly irrelevant in terms of total ventilation rate." He also suggested that the whole dwelling ventilation rate should be uprated.

However, he warned that unless noise was tackled explicitly, mechanical ventilation risked being no more effective than 'natural' ventilation, as occupants would likely turn it off. "Noise is a major issue that needs to be addressed. Too many 'building regs' installations are simply too noisy to use – and when that happens, all the rest of the things we might discuss are irrelevant."

AECB members who wish to contribute to the association's recommendations to the Ministry of Housing are invited to contact Andy Simmonds at ceo@aecb.net. CIBSE is calling on anyone interested in participating in their consultation process to contact them via Julie Godefroy: **jgodefroy@CIBSE.org** ■

New authority to oversee safety in high rise apartment blocks

Words by Kate de Selincourt

(above) Grenfell Tower after the tragic 2017 fire that spurred Dame Judith Hackitt's review

It is being suggested that the creation of a Joint Competent Authority – as called for by Dame Judith Hackitt in her review of the building regulatory system, after the Grenfell tragedy – is due to be announced by the UK Ministry of Housing very soon. And a new industry initiative is calling for Dame Judith's recommendations to be implemented in full.

In all, Dame Judith's report contained 53 recommendations, and she warned at the time that the industry should not be allowed to pick and choose which to implement, because there should be no compromises with people's safety ever again.

According to a report in Building magazine, Secretary of State James Brokenshire will be unveiling an implementation plan — including details of the new Joint Competent Authority to oversee management of safety risks in high-rise residential buildings across their entire lifecycle — before Christmas.

An industry initiative entitled 100% Hackitt was launched in October by the Local Authority Building Control (LABC) and the British Board of Agrément (BBA) to encourage the government to deliver all of the recommendations contained within Dame Judith's report.

According to Inside Housing, at the launch event BBA chief executive Claire Curtis-Thomas suggested that poor procurement practices were to blame for the serious problems with external insulation on buildings.

At the same event, Lorna Stimpson, deputy managing director of the LABC, launched a fierce attack on the deregulation of development control. Calling for a radical overhaul of the regulatory system to return power to building inspectors, Stimpson described the experience of one local authority building control service that had been invited to tender on a complex multi-use £60 million development for which the client had specified that they wanted to procure just 10 inspections for the whole job. "My colleague told them to go away – or words to that effect."

Stimpson reported that the LABC had surveyed public service building control services to ask why local authorities do not often prosecute developers for failing to meet the regulations. She said respondents told the LABC that even when a prosecution is successful, the fines levied are less than the profit that developers make, and the local authority only get court costs back, "not the thousands of pounds it costs to bring cases to court".

"Offenders leave the magistrates court smiling. They keep the profit and can easily start again under a different name. Even worse than that, we know that they will avoid using local authority building control ever again, they'll turn to the private sector. We'll never see their work again, because they know we can prosecute them." ■

Low carbon homes forum to tour the UK in 2019

A series of nationwide forums designed to help housing and construction professionals improve home energy efficiency across the UK has secured support from regional low carbon champions.

The Low Carbon Homes event will be hosted by the Low Carbon Dorset initiative in March 2019, followed by University of Brighton's Clean Growth UK in April and Manchester City Council in November.

Low Carbon Homes is a UK-wide initiative which brings together leading experts to share best practice to help clarify the route towards a low carbon future.

LCH Forums are free-to-attend events open to everyone across the industry, including engineers, local authorities and housing professionals as well as landlords, developers and contractors.

Delegates will have a choice of workshops which will include case studies and success stories as part of a tailored programme created with the guidance of host organisations to meet regional needs.

The 2019 events will each be produced with support from The Green Register, with emphasis on a 'fabric first' approach to low carbon homes.

"The unique platform provided by Low Carbon Homes can facilitate meaningful and practical understanding between those directly involved in many areas of the housing sector," said Lucy Pedler, The Green Register's founder.

Graham Lock, founder of Low Carbon Homes says "As reiterated during the recent Green GB Week, if the UK is to achieve its global obligations, there must be a rapid take-up in domestic energy efficiency – especially in the 80% of existing housing stock which is poor performing. For those working within the housing industry, the subject of energy efficiency has never been so important and we must all play a role in driving forward change."

The events are free to attend. For more information see **www.lowcarbonhomes.co.uk**. ■

Wales votes to cut emissions 80%

The Welsh assembly has voted through new legally-binding carbon emissions targets for the country. The targets bind the country to reduce emissions by 80%, relative to 1990 levels, by 2050.

Energy retrofit of buildings, more energy efficient new builds, and a switch to more sustainable transport options are expected to be among the country's key strategies for reducing emissions.

With its history of heavy industry, livestock agriculture and power generation, the country faces a steep challenge in cutting its carbon emissions.

The government is expected to publish a more detailed action plan on how it can achieve the proposed reductions in March 2019.

Meanwhile, the Welsh government has also effectively banned the opening of any new coal mines in the country, after the government's latest planning policy said they would only be allowed under "exceptional circumstances". ■

Disastrous Preston retrofits make national headlines

Words by Kate de Selincourt

(above) Shockingly poor detailing at the roof line of one of the affected properties in Preston.

The revelations in Passive House Plus issue 24 about failed external insulation retrofits in the Fishwick area of Preston have been followed up by UK national media, putting pressure on Ofgem, the electricity and gas regulator, to make more effort to help those affected. The government has also told Preston's MP it will nominate a civil servant within the Department for Business, Energy & Industrial Strategy to pursue a resolution.

Earlier in the year, Passive House Plus reported on the disastrous scheme, which affected up to 390 homes with water penetration, mould and damp. The installations took place under the Community Energy Saving Scheme, which required energy companies to fund energy efficiency measures in disadvantaged communities and were originally commissioned by InterGen.

In an item on BBC Radio 4's Today programme in November, journalist Zoe Conway reported on the homes described in Passive House Plus, along with other homes in the Fishwick area that had work carried out on behalf of energy company SSE, where similar problems have emerged.

The report also covered two failed cavity insulation schemes, one in Leeds and one in Blackpool. Chartered building surveyor David Walter described the workmanship he saw in Preston to the BBC as "appalling – the worst I have seen".

The report quoted a response from Ofgem stating it was "looking at other options" to assist the affected householders.

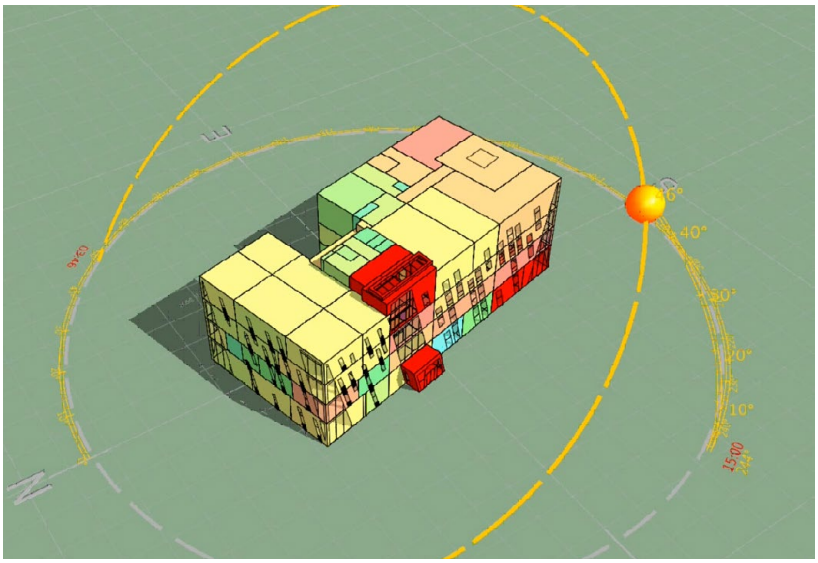
The broadcast was followed by an item in the Mail Online under the headline ''Green' drive leaves thousands of families stranded in homes riddled with damp and mould after contractors bodged the insulation'.

Meanwhile, speaking in an adjournment debate called by the Preston MP Mark Fisher in October, secretary of state Claire Perry laid responsibility at the door of the energy companies and installers, but accepted that, "I do not think what has happened has been good enough."

She added "I am going to instruct one person in my department to act as the broker and bring together all the people who have played a part in the problem and can also be part of the solution.

"It sounds as though InterGen, E.ON [the energy company who commissioned the remediation] and Ofgem also need to be corralled into a place where we can come up with a solution."

Meanwhile, the TrustMark quality scheme for tradespeople announced in October that it has expanded its remit to include the retrofit and energy efficiency sectors. TrustMark was asked by the government to develop a process that could protect householders having work carried out under government schemes like ECO. ■



(above) A still from an animation by Greenlite on the thermal behaviour of the University of Nottingham's Research Acceleration and Demonstration building, showing room temperatures over the course of the hottest simulated day; (above right) Richard Tibenham of Greenlite Energy Assessors.

Buildings need better overheating models to guarantee future comfort

Building designers need to undertake much deeper analyses of overheating risks, and do so under future climate change scenarios, in order to ensure their buildings can adapt and remain comfortable for occupants in a warming world.

That's according to Richard Tibenham of Greenlite Energy Assessors, energy and thermal comfort consultants, who also called for a much more integrated design approach between architects, engineers and contractors to ensure long term comfort for building occupants.

"The magnitude, duration and frequency of heatwave conditions is increasing across Europe as a consequence of climate change, thus the demand for sufficient safeguards is becoming more pertinent," Tibenham said.

"Low energy buildings are at an increased risk of overheating due to inherent design characteristics such as increased levels of airtightness and insulation. Ill-conceived glazing quotas, glazing orientation and shading strategies can present overheating risks, which can be extreme at times."

"There is no requirement under the current UK building regulations to assess overheating risks, and this is manifesting in a moderate number of buildings incurring overheating problems or excessive mechanical cooling loads."

"Predictive weather data combined with accurate thermal modelling suggests that the vast majority of buildings are woefully unprepared for a changing climate."

Tibenham said that the quality of architecture in response to overheating risks varies significantly, with some schemes taking sensible design measures from the early design stages, whilst other schemes take very little consideration of overheating risks at all. Too often, he said, schemes rely on low-g glazing as a cover-all response to excessive glazing quotas, however this can in turn increase winter time heating loads.

He said that in the event that an overheating analysis is undertaken, these often set the bar at CIBSE TM52 compliance using Design Summer Year (DSY) 2005 weather data. "From my own works, whilst these buildings may pass the code when assessed using DSY05 data, they very often fail when tested against 2030 weather data, let alone 2050 or 2080."

"I suspect the outcome will be an increase in the amount of retro-fitted air conditioning systems, which is obviously undesirable when attempting to decarbonise the grid at the same time. This could be avoided however if a longer term stance to summertime comfort were adopted and buildings were tested under the weather conditions likely to be experienced during their operational lifetime."

Dynamic thermal models

Tibenham added: "A dynamic thermal model or DTM can be helpful for any building, and can often turn up some useful and highly detailed design data that would otherwise go unacknowledged. With respect to passive house schemes, a DTM can be incredibly useful in determining localised indoor environments, since the PHPP deals with the building as a whole, rather than as a cluster of interrelated environments."

"For larger commercial buildings in particular, this level of analysis can be highly valuable in avoiding potential localised risks. If sufficiently detailed, the models can also be very useful in assessing the behaviour of complex HVAC networks, and the impact of various control strategies and set-points."

Tibenham said that undertaking a reliable DTM provides a looking glass into the behaviour of a building, and allows the trends and behaviour of various building physics phenomena to be better understood. This understanding, he said, can be fed back into the design cycle and used to better inform future buildings.

"From my experience, building services engineers tend to read the reports, but understandably focus on black and white measurable performance objectives such as Part L outcomes and BREEAM. Many main contractors and architects neither read or understand the reports, leaving the contractual responsibility for thermal comfort solely with the building services engineer. This results in the same problems re-occurring, with the building form and fabric presenting problems which require a HVAC response."

"I am looking to engage with architects and contractors who wish to put the thermal and energy performance of the building at the core of the design process, with the building fabric and building services operating as an integrated system, rather than as separate entities. Early engagement is key to achieving optimum outcomes."

For more information see **www.greenliteea.co.uk**. ■





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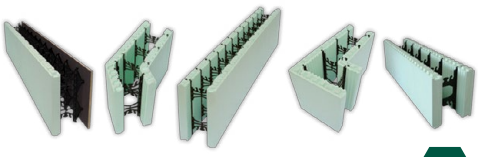

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New Europe-wide boost for energy efficient mortgages

Energy efficient properties less likely to default, research finds

Words by Lenny Antonelli

The Energy Efficient Mortgages (EEM) Initiative has unveiled a new definition for energy efficient mortgages, which is intended to make it easier for the 41 participating lending institutions – including the likes of Barclays & KBC – to offer more attractive finance terms to those buying energy efficient properties.

It comes just as two Bank of England economists have published a statistical analysis demonstrating that energy efficient properties are less likely to end up in mortgage arrears.

The provision of so called 'energy efficient mortgages' that incentivise homeowners to buy or build low energy homes, or retrofit to low energy standards, is seen as an essential driver in pushing the property market towards sustainability. However, to date few such mortgages have been available to consumers. Notable exceptions in the UK include Ecology Building Society's C Change mortgages, which offer preferential interest rates for homes meeting higher energy performance standards, such as passive house, and the Barclays Green Home Mortgage, which offers better lending terms linked to the EPC score of the house.

The new EEM definition says that energy efficient mortgages are mortgages that provide finance for buildings where there is evidence of "energy performance which meets or exceeds relevant market best practice standards in line with current EU legislative requirements" or "an improvement in energy performance of at least 30%", for retrofits.

It adds: "This evidence should be provided by way of a recent EPC [energy performance certificate] rating or score".

At the end of 2017, the 41 institutions participating in the EEM held 55% of mortgages in the EU, meaning the new move could potentially have significant influence in the market.

Commenting on the new definition, Gerassimos Thomas, the European Commission deputy director-general for energy, said that move would "facilitate the implementation of energy efficiency investments where they are most needed, in the buildings sector" and serve as "an important step, opening the way for a quick roll-out of energy efficiency mortgages."

However, there is some concern that EPCs or building energy ratings (BERs, the Irish equivalent) remain an unreliable measure of the energy performance of highly efficient properties, such as passive houses, due to the way they are calculated. For example, the Old Holloway passive house featured on the cover of Passive House Plus issue 27, a certified passive house which has zero space heating bills, only has an EPC rating of C, suggesting that some passive homes with practically no energy bills could struggle to qualify for better financing terms.

Lower default risk

Meanwhile, a statistical analysis published by two Bank of England economists, Benjamin Guin and Perttu Korhonen, has concluded that mortgages on energy efficient properties are less likely to end up in arrears. The analysis, published on the bank's policy blog www.bankunderground.co.uk, examined a sample of 1.8 million properties for which loan performance data and energy performance certificates (EPCs) were available.

The authors classified homes with an A, B, or C energy rating as "high energy efficiency", and homes with an E, F, or G ratings as "low energy efficiency". The authors' initial analysis found that 0.93% of the energy-efficient properties were in payment arrears, compared to 1.14% of the energy inefficient properties — a statistically significant difference of 0.21%.

"Two mechanisms could be driving this difference," the authors wrote. "On the one hand, energy bills are lower on energy-efficient properties. Savings on energy bills could lead to lower arrears rates ('energy savings affect'). Alternatively, high-income borrowers could be more likely to take out mortgages against energy-efficient properties. Such borrowers may fall into arrears less frequently ('income selection effect')."

But the authors ultimately ruled out the 'income selection effect' by comparing mortgage arrears of borrowers with similar income, and found that the difference remained similar between energy efficient and inefficient properties.

They went on to perform tests to control for the possibility that various other factors could be causing the difference, and did find that when they controlled for the year that the mortgage originated and the EPC inspection was performed, the difference in payment arears decreased to 0.10% — but this was still statistically significant.

"We conclude that the energy efficiency of a property is a relevant predictor of mortgage risk," the authors wrote.

For more on the Energy Efficient Mortgages Initiative see **eemap.energyefficientmortgages.eu**. ■

Photo by IAEA

(above) Gerassimos Thomas, EU deputy director-general for energy, welcomed the new definition for energy efficient mortgages.

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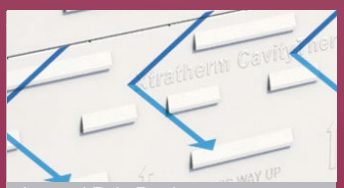
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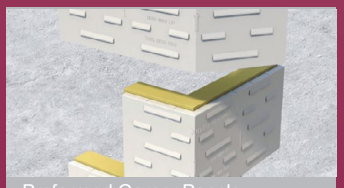
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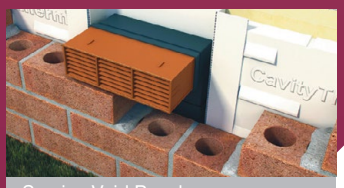
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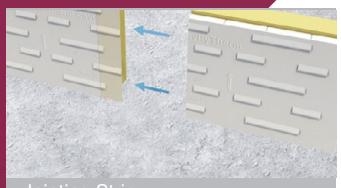
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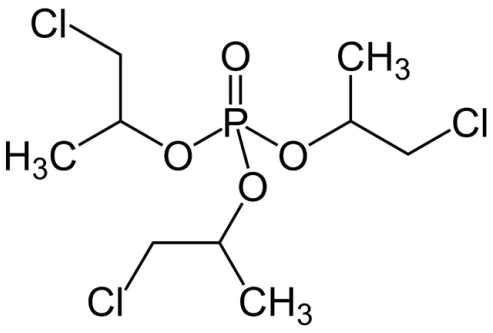


NEW RESEARCH

RAISES SPRAY FOAM HEALTH QUESTIONS

New studies are seeking to answer questions about how spray foam insulation, and materials containing formaldehyde, affect indoor air quality — and some of the early results are worrying.

Words by Kate de Selincourt

Preliminary research into emissions from cured spray polyurethane foam (SPF) insulation suggests that potentially harmful substances may continue to be emitted from the insulation long after it is installed. One study found that the flame retardant TCPP appeared to be off-gassing from spray foam two years after installation.

Speaking at an event held by the UK Indoor Environment Group (UKIEG) in May, UK scientist Dzhordzio Naldzhiev discussed both his own research at UCL, and research carried out by the US National Institute of Standards and Technology (NIST).

In lab tests at NIST, Dr Dustin Poppendeik and colleagues[1] found a number of volatile organic compounds emitted from four different cured spray foam specimens: two relatively fresh samples (one open-cell, one closed-cell) supplied by an industry body, the American Chemistry Council, and two older specimens from real-life installations (again one open-cell, one closed-cell). Numerous compounds were detected – up to 80 in the case of one sample.

The concentration of most of the volatile compounds fell progressively in the test chambers over time, however for the two open cell samples, levels of the semi-volatile flame-retardant tris (1-chloro-2-propyl) phosphate (TCPP) remained steady. Similar results were also seen with one of the closed-cell samples.

The authors suggest the unchanging emissions may have been because levels of flame retardant were high in the finished foam (the researchers cite reports that TCPP may comprise up to 12% of the mass of some spray foam formulations), meaning concentrations in the foam did not fall as the flame retardant "offgassed". They also note that emission rates varied by up to an order of magnitude for apparently similar products, meaning it was not possible to generalise conclusions from one foam to another.

Even though TCPP is a common ingredient in polyurethane foam products, there are no currently agreed exposure limits for the flame retardant[2]. However, as the NIST researchers point out, TCPP is classified by the EPA Design for the Environment Program as having "a high hazard for reproductive and developmental effects".[3]

The NIST researchers also measured levels of TCPP in the air of a test dwelling that had had the basement insulated with open-cell spray foam, two years previously. As the house was unfurnished, there were no other potential sources of flame retardant such as foam furniture to confuse the results.

According to the research, which was also discussed by Dzhordzio Naldzhiev at the UKIEG event[4], TCPP was detected in the air in the ground floor of the house, and in the basement. As levels in the basement were approximately double those in the house, the researchers concluded that the spray foam there was almost certainly the source of the TCPP in the building.

The team had found that in the lab, TCPP emissions from open cell foam rose exponentially with temperature. This effect was echoed in the test house (see graph). The temperature in the basement was raised from just above 21C to around 28C – the sort of rise that can be expected during heat waves. Repeat sampling showed levels of TCPP in the basement air rising from around 2-3 μg/m^3 at 21C to 7-12 μg/m^3 at 28C – at least a three-fold increase.

These findings "suggest that occupants may be exposed to measurable concentrations of the flame retardant TCPP two years after application of open-cell foam," the researchers wrote.

The US authors added the caveat that with only one real-life example tested, the research is still very limited, and it is not known how dependent emissions are on the particular product, or the way it was installed.

Among the other compounds emitted from the spray foam specimens when they were fresh, Dustin Poppendieck and his colleagues at NIST detected 1,2 dichloropropane (1,2- DCP) and 1,4 dioxane. "1,4 dioxane is commonly detected emitting from closed-cell SPF [spray polyurethane foam]," the authors say.[5] Canadian researchers have also reported that tests on spray foam specimens detected 1,4 dioxane.[6]

1,2- DCP and 1,4 dioxane are classified respectively as carcinogenic,[7] and possibly carcinogenic. However, little is known about how they originate and whether they pose a health hazard in real-world applications, or even the best way to measure the chemicals.

At UCL, Dzhordzhio Naldzhiev is starting the process of investigating emissions of 1,4 dioxane, 1,2- DCP, and other VOCs, from samples of different commercially available spray foam products, refining the measurement process so that a standardised method can be developed.

Naldzhiev told the UKIEG that, as part of as-yet unpublished research, he and his colleagues analysed three commercially available spray foam products to see if these two VOCs were present, and whether it was

possible to work out where they originated. The lab had detected 1,2- DCP being emitted from all three cured samples, and 1,4 dioxane only from one – but both compounds were found in the raw ingredients.

It has been suggested in the US literature that 1,4 dioxane and 1,2- DCP may be breakdown products of TCPP.[8] Although they say they can't be sure either way, Dzhordzhio Nadzhiev and his colleagues believe these VOCs might instead have found their way into the foam as constituents of raw SPF product, possibly as contaminants, so it might be possible to modify the manufacturing process to reduce or eliminate them.

Dr Naldzhiev's team plan to investigate further, to establish the 'real life' levels of VOCs emitted by various spray foam products over one to two years or longer, and whether these are high enough to warrant concern. He added: "It is important to find the source and quantity of such emissions as it is a better strategy to eliminate them at the source, rather than mitigating them through ventilation strategies."

He and his colleagues are concerned that use of SPFs is outstripping understanding of their possible impacts on the indoor environment. In a research paper presented at an international ventilation conference in 2017,[9] they wrote that "the potential long-term impact of these buildings materials and what ventilation strategies should be in place throughout the lifecycle of the building, in order to provide healthy IAQ, is still widely unknown."

Persistent formaldehyde off-gassing

Another apparently persistent compound discussed at the UKIEG meeting last year was formaldehyde, which also appears to persist for a year or more after the completion of construction, and does not necessarily drop to safe levels before occupants move in.

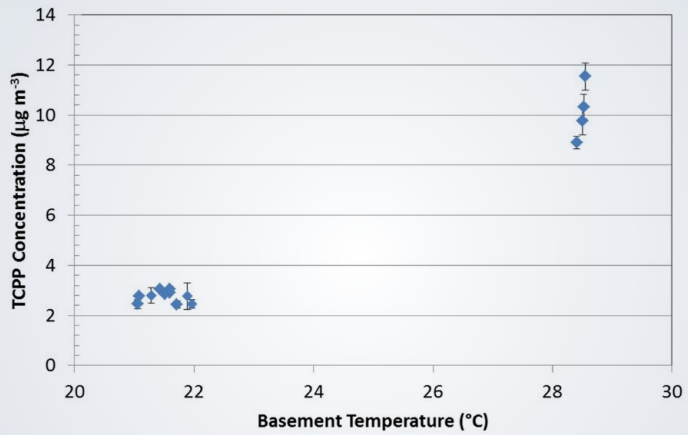
Formaldehyde is a known irritant and suspected carcinogen, emitted by many engineered wood products and other construction and fit-out materials.

As part of as-yet unpublished research, Dr Clive Shrubsole and colleagues at UCL in London and Tsinghua University, Beijing, monitored a number of chemicals in indoor air in a range of buildings, including schools, offices and homes, in the UK and China.

Dr Shrubsole told the UKIEG: "We found formaldehyde levels of three times the recommended emission limit value in all the apartments we monitored, more than three years after the buildings were completed." This raises a question over the perceived wisdom that formaldehyde will have mainly off-gassed within a couple of years, Dr Shrubsole warned.

Dr Shrubsole's findings were not an isolated instance. Tim Robinson of air testing company Waverton Analytics has also found elevated formaldehyde levels in a building post-occupation. He told a meeting of the Alliance for Sustainable Building Products in 2017[10] that he had recorded formaldehyde at ten times the WHO recommended limits in a school in Northwest England, one year after the building was occupied. Staff and students had complained of symptoms such as eye and throat irritation.

However, the UCL/Tsinghua study found "no notable" formaldehyde in a building which had been constructed to a low-emissivity specification. This suggests source control can be effective.



TCPP concentrations in the basement of a test house at different temperatures; the basement had previously been insulated with open-cell spray foam. From: Flame Retardant Emissions from Spray Polyurethane Foam Insulation D. Poppendieck, M. Schlegel, A. Connor, A. Blickley NIST

Spray foam installation: What installers & occupants need to know

There is long-standing concern about emissions during and immediately after insulation spraying, and what this means both for construction workers, and for occupants entering or re-entering a treated building. Isocyanates ("MDI") are one of the main ingredients of spray foam – they comprise the "A" side in two-component foams. Isocyanates are an irritant and can cause a dangerous asthma-type reaction in people who become sensitised to them. Advice on the website of the US Environmental Protection Agency (EPA)[11] warns of the following in relation to Isocyanates and other spray foam ingredients:

- Spray application generates isocyanate vapours and aerosols. Isocyanates can cause "sensitization," which means that some people may become allergic to isocyanates and could experience allergic reactions including: itching and watery eyes, skin rashes, asthma, and other breathing difficulties. Symptoms may also be delayed up to several hours after exposure.
- If you are allergic or become sensitized, even low concentrations of isocyanates can trigger a severe asthma attack or other lung effects, or a potentially fatal reaction. There is no recognized safe level of exposure to isocyanates for sensitized individuals.
- Research data indicates that inhalation exposures during SPF insulation [installation] will typically exceed US Occupational Safety and Health Administration (OSHA) occupational exposure limits (OELs) and requires skin, eye and respiratory protection.
- Vapours and aerosols can migrate through the building if the area is not isolated and properly ventilated.
- After application, vapours may linger in a building until properly ventilated and thoroughly cleaned.
- Cutting or trimming the foam as it hardens (tack-free phase) may generate dust that may contain unreacted isocyanates and other chemicals.
- After application, dust may linger in a building until properly ventilated and thoroughly cleaned.

[1] 'Lessons Learned from Spray Polyurethane Foam Emission Testing using Micro-chambers'; Dustin Poppendieck, Mengyan Gong, Lauren Lawson, National Institute of Standards and Technology (https://ws680.nist.gov/publication/get_pdf.cfm?pub_id=921259) [2] (A Research paper published by the American Chemistry Council in 2014 says: "There is no Occupational Safety & Health Administration (OSHA) permissible exposure limit (PEL) nor American Conference of Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) guideline for the flame retardant, Trichloropropyl phosphate (TCPP).") [3] USEPA, 'Flame Retardants Used in Flexible Polyurethane Foam: An Alternatives Assessment'. Update. In Environment, D. f. t., Ed. U.S. EPA: 2014 cited by Poppendeik et al 'Flame Retardant Emissions from Spray Polyurethane Foam Insulation'. [4] 'Flame Retardant Emissions from Spray Polyurethane Foam Insulation'; D. Poppendieck, M. Schlegel, A. Connor, A. Blickley, National Institute of Standards and Technology. [5] 'Lessons Learned from Spray Polyurethane Foam Emission Testing using Micro-chamber'; Poppendeik & al. [6] NRC Publications Archive / Archives des publications du CNRC, 'Material emissions testing: VOCs from wood, paint, and insulation materials'; Won, Doyun; Nong, Gang; Yang, Wenping; Collins, Peter (http://doi.org/10.4224/23002015). [7] https://monographs.iarc.fr/list-of-classifications-volumes/ [8] Salthammer, T., Fuhrmann, F. & Uhde, E., 2003. 'Flame retardants in the indoor environment—part II: release of VOCs (triethyl phosphate and halogenated degradation products) from polyurethane.' Indoor Air, Volume 13, pp. 49-52. [9] https://www.aivc.org/news/aivc-conference-2017 [10] https://asbp.org.uk/wp-content/uploads/2017/02/tim-Robinson-Waverton-ASBP-Expo-15-02-20171.pdf [11] https://www.epa.gov/saferchoice/potential-chemical-exposures-spray-polyurethane-foam

Neil May 1962-2018

"Only if we are capable of dwelling, only then can we build." *Heidegger*

Neil May was a charismatic leader of our industry, a powerhouse of ideas who challenged and inspired everyone he worked with. The theme of his work was better buildings – not just better functionally or architecturally but also socially, culturally, ecologically and philosophically. He taught us to think about what buildings are for, what their place is in our heritage and society, the role they should fulfil in our future, and how they should perform. In his own words:

> What are buildings for? And that leads to the question: what are human beings for? What is our purpose? We need to think deeply about that if we are to create a future that is sustainable as well as meaningful. Buildings are manifestations of the values of our society and if we want to have more beautiful, sustainable and creative buildings then we have to address our core values first.

Neil studied for his first degree in Modern History at Oxford and went on to take an MPhil in Sociology at Delhi University, where he was a Commonwealth Scholar and specialised in cultural anthropology. He conducted extensive field work in and around Delhi and made a documentary film in Bihar. Neil remained in contact with leading anthropologists and social thinkers in Delhi, where his work is still respected. In 1988, having returned to the UK, he became a building labourer for four years before setting up his own award-winning ecological and conservation building company, Neil May Builders, which he sold in 2004.

At heart, Neil was always a builder – he knew how to put buildings together, and his straightforward, practical manner often somehow conveyed the impression that he had just been building a wall or installing some plumbing. Yet he was equally comfortable with professionals, academics and civil servants. Working with academics, he encouraged them to focus on making their work useful; but with professionals he insisted on systematic research and evidence-based conclusions.

Neil founded Natural Building Technologies in 1999, and pioneered the supply of high-performance sustainable, vapour permeable insulation and envelope systems for buildings. While managing director of NBT he set up the Better Buildings Group, including many leading energy and sustainability consultants who held meetings and seminars in NBT's chilly warehouse near Aylesbury. Neil inspired the group's work promoting sustainable new-buildings and sustainable retrofit. One member of the group recalls "his passion for buildings, people and nature, (always those three things inextricably linked together) and his slightly bemused irritation that the construction industry and so much of society just didn't 'get it', particularly when the evidence was clear for us to see." Neil also contributed sustainability workshops to the senior management development programme of a leading building company, where he is reported to have astonished the delegates with his insight into the many and various unintended consequences of poor design.

In 2005, Neil brought together a group of natural building developers to campaign against the poor standard of performance of new homes in the UK. This was the start of a long collaboration with the Sustainable Development Foundation, which resulted in the creation of the Good Homes Alliance, the Passivhaus Trust, the Alliance for Sustainable Building Products and the Sustainable Traditional Buildings Alliance, each of which campaigned to change practice relating to performance problems that Neil had identified. Neil was instrumental in establishing and nurturing all these organisations, before moving on to sort out the next problem on his list! As a colleague remarked "Neil had the wonderful gift of bringing people together into communities of interest, creating what at first seemed to be niche groups but ended up becoming hugely influential for change at a national level."

When the UK government conceived the Green Deal, Neil was appalled by the potential for damage to our homes and architectural heritage from large-scale retrofit using inappropriate materials and techniques, a cause he took up with the Department for Energy and Climate Change (DECC). One civil servant at DECC recalls him as "A passionate

lobbyist for doing the right thing, who did it in the nicest possible way. You had your arm twisted without realising it." For the Sustainable Traditional Buildings Alliance, Neil secured DECC funding for research that led to the influential report Responsible Retrofit of Traditional Buildings and the development of the well-known Guidance Wheel.

Neil also contributed to the Each Home Counts review, and joined the BSI Retrofit Standards Task Group, where he was influential in establishing a holistic vision for the retrofit standards framework called for by the review. This in turn influenced the scope of BSI's forthcoming domestic retrofit standard PAS 2035 Retrofitting Dwellings for Improved Energy Efficiency, for which Neil served as a member of the industry steering group.

Neil's work on responsible retrofit led to an opportunity to join the Institute for Environmental Design and Engineering at University College London (UCL) as a Senior Research Fellow. He had an immediate impact: as one colleague put it: "I am one of many with whom Neil collided and bounced off, sending us in new directions. He changed the way I think about housing. The intellectual challenges he posed were matched by personal warmth which made engaging with his ideas much more than just another collaboration."

Neil was also influential in establishing a 'systems thinking' approach within the Institute – he guided the development of the ground-breaking Housing, Energy and Wellbeing project. Colleagues in UCL's Bartlett School of Planning report that his enthusiasm for thinking differently about the housing crisis was infectious. "We quickly understood that his knowledge and interests were almost boundless. UCL's 'Rethinking Housing' initiative followed, bringing together researchers from UCL and beyond, and a new urgency in our housing work – driven by Neil."

The work on responsible retrofit also led Neil to BSI, where he collaborated on a White Paper on Moisture in Buildings, which advocates a new principles-based approach for moisture risk assessment that is being incorporated in a new edition of BS 5250 Code of practice for the control of condensation in buildings. His collaborator writes "Meeting Neil was a shock to the system, he had so much enthusiasm, so many interests, so many new perspectives on well-trodden ground and so much warmth and friendship. The White Paper stands as a tribute to him."

In parallel with the BSI work, the most recent of Neil's projects was the establishment in 2016 of the UK Centre for Moisture in Buildings, at UCL. The Centre brings together partners from UCL, BRE, Heriot Watt University and the London School of Hygiene and Tropical Medicine. Already UKCMB has over twenty projects completed or in progress, funded by Government, a research council, charitable trusts, industry bodies and commercial clients and sponsors, all driven by Neil's enthusiasm. He led major projects for BEIS, Bristol City Council, Historic England and the National Trust. The UKCMB has also launched a training programme that promotes the principles of moisture risk management that Neil identified for the BSI White Paper and BS 5250.

> A passionate lobbyist for doing the right thing, who did it in the nicest possible way. You had your arm twisted without realising it.

A UKCMB academic at UCL writes "I feel honoured and privileged to have worked with Neil and been a part of UKCMB, the last of his countless brainchildren. We worked, conversed, argued and laughed – he never ceased to surprise with the depth and richness of his intellect and experience". Another member of UKCMB remarks "Neil was interested in people as much as what they had to contribute, and it wasn't long before we became friends as well as colleagues. I was impressed that, no matter how complex or mountainous a task, he was never fazed. His knowledge and intellect allowed him to join up the dots. Much good has stemmed from that, and it will continue to be his legacy."

An industry colleague remarks "Neil knew what sustainability meant for buildings and crucially for people – the two were inseparable and had to be in harmony. This understanding elevated his work beyond a technical level and made him effective in communicating his vision to others."

Neil was an adviser on environmental and building matters to the Benedictine Community at Quarr Abbey on the Isle of Wight, and he took a group of UCL colleagues there to experience the life of the monks and help them understand Neil's own life and research philosophy. Of his work for the community, Neil wrote: "Part of its mission is to present an alternative and challenging vision of what it means to be fully human, and that is why I am involved."

In 2017 Neil was awarded an MBE 'for services to sustainability and energy efficiency in buildings and communities'. In 2018, faced with an inevitably fatal condition and having survived one operation, Neil bravely chose to put his affairs in order, hand-over his work to colleagues and submit to a second, very risky surgical procedure. The outcome was this tragic loss, which for so many of us is painful and personal, but he has left us an immense and inspiring legacy of ideas and challenges. ■

This obituary has been compiled from material contributed by some of Neil's many friends and colleagues, including academics at UCL, members of the organisations he helped to found and run, and individuals who worked with him.

Case study houses: 1945 - 1962

In his latest piece on the evolution of low energy design, Dr Marc Ó Riain focuses on a postwar architectural movement that fused passive solar design with innovative materials in an attempt to deliver scalable, quality housing.

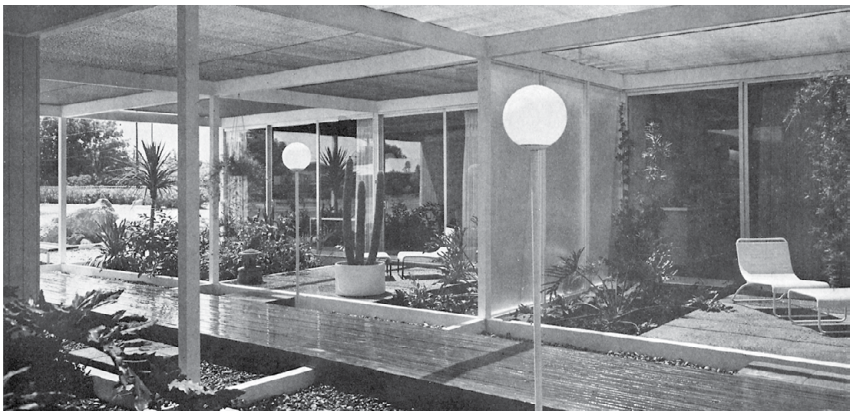
By the end of WW2, many European architects had relocated to the US forming a new definition of modern architecture. In the US Gropius had argued for an architectural regionalism, varying solutions to local climates.

The technology and knowledge of solar houses were being promoted to architects and their clients by publications like 'Tomorrow's House' (1945) and 'Your Solar House' (1947) illustrating that architects of the time were well aware of the principles and technologies of solar architecture. Orientation, overhanging shading devices, double glazing, concrete floor slabs, thermal mass, underfloor heating, and water attenuation for evaporative cooling were all known and applied solutions. But the war period had resulted in limited housing production, a shortage in materials and a lack of skilled labor, and as WW2 ended the US was facing into an immediate oil and housing shortage.

One-off housing would not be able to address the housing shortages that faced the US as soldiers returned from war. Developers were best positioned to respond to this housing crisis in a meaningful way through larger housing developments known as 'tract' housing. John Entenza's Arts & Architecture sponsored a 'case study house program' over a 17-year period around Los Angeles to illustrate how modern architecture could be harnessed to address this housing need.

Fearing the potential dominance of developer-led housing, and their focus on conservative or well-established vernacular architecture, Entenza sponsored a program of low cost, small single-family housing from 1945-1962 (McCoy 1962) with standardised elements, using modern materials and new technologies which had arisen for the war. The aim of the 'Case Study House Program' (McCoy 1962) was to create template-comfortable modern houses that could be replicated as tract housing and adopted by developers. These houses were designed by young architects like Eames, Saarinen, Koenig, Neutra, Elwood and Soriano. The Eames house is well known but atypical of the rest of the program, in that it did not address the key functional needs of providing accommodation for a young family with two children.

Talented young architects were challenged to develop modern solutions to middle class living. The case study houses were small (1,600-2,000 sq ft), but elegantly planned, with two bedrooms and two bathrooms, close in ethos to the social planning of Wright's Usonian houses.



(above) Killingsworth, Brady, Smith & Associates' Triad apartment scheme in La Jolla was part of an attempt to change developer-led tract housing. Photo: Arts & Architecture

The designs which can be loosely divided into steel frame and timber frame post and beam structures were all located in the suburbs around LA. The architects demonstrated a strong sense of climate awareness and were very challenged by the lack of materials and technological limitations. Most of the designs were single-storey, based on flat underfloor heated floor slabs, with floor to ceiling glazing (some single and some double). They were oriented towards the sun and garden, and away from the street, with large overhangs to create solar shading. The architects designed the houses with informal open plan kitchen / living room spaces, eliminating corridors and gaining bathrooms for each bedroom. Outdoor spaces were integrated intelligently into the designs and often part of the internal plan, with Ralph Rapson's 1945 Greenbelt house split by an internal garden. Smith's 1945 'Loggia House" used Adobe to insulate the building from "warm Pasadena Summers" (McCoy 1962) and Wurster/Bernardi's 1949 case study house had 1/3 of the roof glazed with louvres for sun control.

The case study houses were opened to the public with the first six houses attracting 368,554 visitors or about 20% of the city's population. Disproving the lenders and the developers some of the houses sold for 90%-125% more than their build costs in the early 1960s. Entenza had intended to create buildings that could change developer-led tract housing, but this was never realized outside of a small development in La Jolla, and some apartment schemes in the mid 60s. Despite this, the principles of planning, materiality and design remain a core part of today's architect's response to the design of houses. Wouldn't it be wonderful if we could produce passive houses today with the joy and lightness of these buildings? Perhaps we can! Ester McCoy's or Taschen's books on case study houses are great for more detail.

Whilst the case study houses signaled a departure towards modernism in US residential architecture, other programs and other architects were moving toward a more scientific method of designing housing.

In the next issue we will look at emergent trends in science of housing design in the post war period. ■

Dr Marc Ó Riain is a lecturer at the Department of Architecture at Cork Institute of Technology, one of the founding editors of Iterations design research journal and practice review, a former president of the Institute of Designers in Ireland, and has completed a PhD in low energy building retrofit, realising Ireland's first commercial NZEB retrofit in 2013.

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What is a sustainable office building?

As buildings with questionable sustainability credentials are lauded for their greenness, Dr Peter Rickaby puts forward his vision for a genuinely sustainable office building.

The claim that the new Bloomberg European Headquarters building in London is "the world's most sustainable office building" caught my eye. Even with a BREEAM score of 98.5% the claim clearly isn't true: the building must have a huge carbon footprint associated with the journeys to work of the 4,000 people who work there. And what about the 600 tonnes of Japanese bronze and 10,000 tonnes of Indian granite? And a deep plan lit by half a million LED lamps? Credit is due to the clients, architects and engineers for making an effort, but this is not a sustainable building. It is just a little less unsustainable than the buildings that surround it. There must be some passive house office buildings out there that get much closer.

This set me thinking about what a truly sustainable building might be like. If it meets the Bruntland definition of sustainability it would leave little or no environmental footprint. I have never seen such a building. Well, maybe one – the forester's self-build house in the woods that was featured on Grand Designs a few years ago. But what characteristics might a sustainable office building have?

First, it would not be big. The bigger the building the more people will work there and the further they will have to travel, so it's a local office or perhaps a local work centre. The occupants live locally and arrive on foot or by bicycle. (Or perhaps they all work from home and don't need an office building.) If it's too big it will have either a deep plan needing artificial lighting and air conditioning, or a complicated shape that will facilitate daylighting but increase surface area and heat losses. Or it may be tall, needing more structural material and lifts. I think our sustainable office building would be compact, not too densely occupied, and day-lit - small is beautiful!

Second, it would be made of sustainable materials that need little or no fossil fuel to produce, and preferably could be sourced locally. So, no concrete or steel. Aluminium might be acceptable – most of it is smelted using hydropower, and almost all of it is recycled, but it travels a long way. Glass is a problem – it takes lots of energy to manufacture (you must melt sand) and nobody does it with renewable energy yet. But glass is quite useful for letting daylight in and providing views out, while keeping out the rain and wind, so we may have to wait for low-carbon glass, and in the meantime use less glass, and re-use what we have.

The structure would be timber, I think – trees remove carbon dioxide from the atmosphere and sequester carbon in timber. So long-life, re-useable timber frames and cladding perhaps? Bricks and clay tiles need firing in kilns, and they are heavy to transport, so they don't seem a good idea.

Floors would be timber. The roof would be a green roof or covered in slate or timber shingles. Insulation could be cellulose, cork, flax, hemp, wood fibre, sheep's wool or straw bales – there are lots of options! There would be no oil-based plastic insulation boards or mineral fibre (which involves melting rock). Whatever we use, the building elements would have to be quite thick.

> Our sustainable office building would be highly insulated and airtight, so it would need little or no heating, other than by internal gains, but it would be lightweight so keeping it cool might be a problem.

Our sustainable office building would be highly insulated and airtight, so it would need little or no heating, other than by internal gains, but it would be lightweight so keeping it cool might be a problem. However, internal heat gains would be low, because of modest occupant density, and energy efficient lighting and IT. Solar gains would be reduced by shading or shutters. It would be good to introduce some thermal capacity somewhere, to smooth the internal temperatures, possibly via a local stone ground floor. A hybrid of smart natural ventilation (lots of controllable openings, including in the roof) with demand-controlled decentralised mechanical extract ventilation might be an option.

Heat and hot water demand would be met by solar thermal systems and electric heat pumps. Power would be provided by community wind turbines, by wind farms connected via the national grid, and by roof-mounted solar photovoltaics. The power distribution system would be low-voltage DC, which suits both solar PV and computer systems, and minimises transformer losses. Diurnal and inter-seasonal energy storage would be provided by tanks and batteries.

Overall, our sustainable office building would of course be a certified passive house, and (by virtue of the renewables) an nZEB. It would also be manufactured off-site, delivered in panel form (because delivering volumetric buildings, i.e. transporting air, is a waste) and assembled on site. When no longer needed it would be reconfigured, or dismantled and reassembled elsewhere, and some elements might be recycled. I wonder what its BREEAM score might be? ■

Dr Peter Rickaby is an independent energy and sustainability consultant and Chair of the BSI Retrofit Standards Task Group.

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THE DEEPEST GREENEST RETROFIT EVER?

With obsessive attention to preserving and restoring the original fabric of these two Victorian townhouses, and a commitment to shunning petrochemicals and using only natural materials, could this be the most wildly ambitious and sustainable passive retrofit ever undertaken in the UK?

Words by John Cradden

-£43

per year (estimated total energy costs)

Building: Deep ecological retrofit of two Victorian townhouses

Location: Chorlton, Manchester

Completed: Autumn/winter 2018

Final cost: £1.83m (estimate)

Standard: Enerphit Plus

WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie

The leafy suburb of Chorlton seems like a fitting location for a passive house project that looks to have broken new ground in a number of exciting ways. Well known as the liberal heartland of Manchester, Chorlton is sometimes derided for being a bit too bohemian/lefty/middle-class for its own good, but if that's the price to pay for being the location of what may well be the most sustainable passive house retrofit ever carried out on a period property, then so be it.

A pair of semi-detached Victorian townhouses on Zetland Road in the sought-after M21 postcode have been retrofitted not just to the Enerphit standard — the passive house benchmark for retrofit projects — but to Enerphit 'Plus', which is awarded to buildings that also generate at least 60 kilowatt hours in renewable energy each year per square metre of floor area.

But besides being the first Enerphit Plus project in the world, its developer also took a vastly ambitious approach to reducing the overall carbon footprint and environmental impact of the build.

For a start, the building fabric contains practically no petrochemicals, all the materials and construction details are fully breathable, the dwellings still sit on their original footprints, and almost all 200 tonnes of brick in the property as well as all the original joists and rafters are still in place.

"It's keeping the embodied energy, the embodied carbon that was put in there when it was originally built… keeping that on site," says its developer, Kit Knowles.

Knowles was keen to take a fresh approach to the deep retrofit of a period property, where he says the usual passive retrofit strategy is to, "strip everything out from the inside, demolish bits that are hard to treat or get in the way, extend to accommodate a modern living format, send all the waste to landfill, then bring in new petrochemical fabric as a replacement."

And while this magazine has featured various projects over the years that roughly fit that description, many of which were important milestones in demonstrating

> His philosophy was to make every layer in the walls, roof and floor highly breathable.

just how dramatically you can improve the thermal performance of historic dwellings, Knowles's approach was markedly different.

A chemical engineer by training, Knowles now runs Ecospheric, a consultancy specialising in sustainable construction, and which also supplies high performance timber windows. His CV includes stints with BP and pharma giant AstraZeneca but underpinning a lot of his work for those firms was a zeal for integration engineering.

This, together with the fact that he comes from a family of architects (both his parents, a cousin and a sister) — who would frequently talk about how new energy-efficiency technologies were being "strapped" onto houses without any thought about how well they worked together — provided him with the initial spark to build an expertise in sustainable building.

Green pioneer

Ten years ago, Knowles and his wife Ellie deep retrofitted their own 100-year old Arts-and-Crafts style semi-detached home in Chorltonville into a 'SuperHome', a UK standard that requires homeowners to cut their dwelling's carbon emissions by 60% (they achieved 81%) and then open its doors once a year to the public.

Knowles says that the project was "kind of a laboratory", featuring test-bed technologies like hybrid heat recovery with passive stack ventilation, the first use of Spacetherm aerogel external wall insulation, hybrid solar PV-thermal panels, and a solar-powered rainwater harvesting system.

For this project, he was keen to focus on the type of domestic property categorised by the British government as 'hard to treat', which constitute around one third of the 24 million homes in the UK.

"The eight million pre-1930s dwellings became my bread and butter and was where I built up a lot of my knowledge base," says Knowles, who closed his old consultancy two-and-a-half years ago and set up Ecospheric with the aim of producing, "exemplary pilot projects that set new standards, solved problems and filled the gaps in the built environment."

After an extensive search, Ecospheric bought Ingleside and Woodleigh in 2016, two adjoining semi-Ds on Zetland Road that were for sale as one unit. Built in 1894, the four-storey townhouses (including basements) were bought from a landlord's portfolio and had been sub-divided into five separate apartments across the two buildings. They were in a poor state.

Knowles says the firm initially wasn't planning to go as far as it did with the project, but their confidence grew when the housing market started shifting strongly in an upward direction, prompting them to be more ambitious about the engineering behind it.

The finished houses are stunning to look at, inside and out. The front façade looks suitably traditional, featuring what Knowles believes are the first stained glass external windows used in a passive house project. The windows were developed by Ecospheric Windows & Doors and their manufacturing partner, Viking, after extensive surveys of traditional stained-glass patterns in the area.

At the west-facing timber-clad rear of the buildings, the first-floor windows are angled southward to maximise solar gains. In fact, the rear wall at ground floor level was the only external part of the building to be altered structurally, with the removal of the external brickwork. The large new glazed elements here left so little original brickwork behind that it was no longer structurally viable.

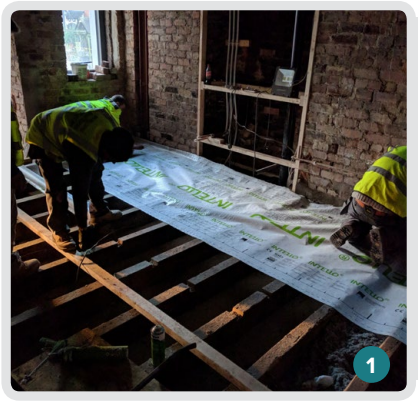
Painstakingly upgraded fabric

Knowles was conscious of the risk of overheating, but at Zetland Road the solution was to "keep the brick fully connected to the space within the property" in order to exploit its high thermal mass, that is, its ability to smooth out internal temperatures by absorbing and slowly releasing heat. So, on most internal walls the brickwork was simply parged with lime — which also provides thermal mass — and left exposed to the interior.

Meanwhile, the exterior is clad in ▶

Photography: Rick McCullagh

CONSTRUCTION IN PROGRESS



1 The team preserved the original 175mm deep floor joists, which were insulated with cellulose, with Steico Protect Dry woodfibre insulation below the joists; and **2** an Intello or Siga airtightness and vapour control membrane above.

Organowood, a Swedish wood product distributed in the UK by sustainable wood specialists Ecochoice, which takes a novel, inert, approach to wood preservation: fossilisation. The patented system was developed based on the principle of biomimicry - learning from nature – to eschew the use of synthetic chemicals by partially fossilising the timber. According to Mike Bekin of Ecochoice, Kit Knowles approached Ecochoice looking for a product that was low footprint in terms of a full cradle-to-cradle approach – transport miles, durability, economics, chemical use, etc. "We see this as the successor to chemically-impregnated timber because the technology is virtually the same," said Bekin, "but they've replaced the biocide heavy metal chemicals for inert silica which happens to be the second most abundant element on the planet." Bekin explains that Organowood's unique patent-protected process involves disolving the silica onto the wood, and then letting it harden once inside the wood.

The rear façade also has rainwater goods and coping made of copper with a claimed 120-year lifespan, while a whopping 60 square metre array of solar photovoltaic panels on the roof generates an average annual output of 8,740 kWh.

The walls of the houses are solid brick, and in places a second inner leaf of brick was removed. The side walls were externally insulated using Steico's FSC-certified timber I-joists, which were insulated with cellulose, covered with wood-fibre, and finished in lime.

The internal insulation to the front façade is again comprised of Steico's timber I-joists, blown cellulose and wood-fibre board — but with a 38mm ventilated cavity between the old brickwork and the new insulated layer. Inside, the walls throughout the house were parged in lime and painted with Graphenstone paint, made from a combination of graphene and lime that claims to be truly crack-proof.

The blackest art

Describing construction's fight against moisture ingress as the "blackest of black arts", Knowles was keen to ensure that all the walls and construction details were genuinely breathable and diffusible. While a common approach in construction is to have a gradient of breathability across a wall, Knowles say this often results in an interior

> There's this kind of acoustic quality about the space... like nothing else they've ever experienced.

layer that restricts the movement of moisture.

His philosophy instead was to make every layer in the walls, roof and floor highly breathable all the way across, to support drying both inside and out, should any moisture get in.

"Broadly speaking the long-term success of building fabric is dependent upon detailing, but even with perfect solutions on paper, faults will always occur during construction or during occupation. A much better approach is to design the fabric to dry quickly once wetted, a better form of redundancy."

He adds: "It's impossible to stop water getting in. You can't rely on your layers being absolutely perfect. It's about making sure that any moisture that does get in there can readily dry out."

It may seem somewhat ironic that, for a project that aims to preserve as much of the building fabric as possible, Ecospheric ended up spending far more than it budgeted on the building fabric. However, part of this was clearly down to Zetland Road being a test-bed for a "breathable, organic, fabric-retaining solution" for passive house retrofits.

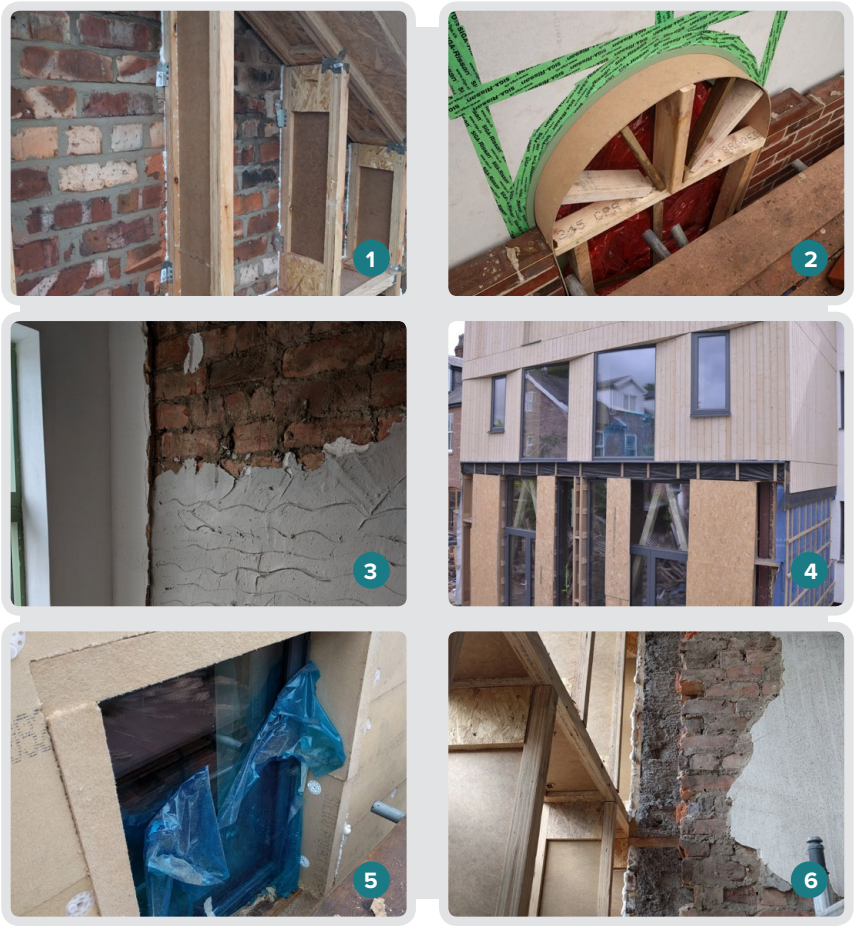
"It was very uncompromising as a project," Knowles says. "Although it's not economic in its own right, it means that we've got the solutions moving forward."

Lime

The first area of overspend concerned the bay windows, which needed new foundations, as the original Victorian ones were very shallow and not designed to last 125 years. So, after looking at a lot of different options, the team decided on a kind of aerated bench block system that uses just a fifth of the amount of concrete compared with traditional systems.

Another area of overspend was in trying to hone the use of lime-based products. Knowles is a "massive fan" of lime, namely because of its breathability, ability to sequester volatile organic compounds and carbon, buffer moisture, and prevent mould build-up thanks to its alkalinity.

CONSTRUCTION IN PROGRESS



1 The Steico i-joist system installed here against the original brick wall of the front façade; **2** the need to preserve the building's historic appearance posed numerous technical challenges, such as for sealing and installing a fan light above the entrance; **3** lime parging to the party walls; **4** construction of the rear facade, which features the Steico i-joist system with cellulose insulation and Organowood cladding externally; **5** installation of Viking triple-glazed timber windows into a layer of Steico Protect Dry wood fibre insulation on the side walls; **6** Adjoining the old brick party walls, the rear ground floor was the only part of the house where entirely new walls were constructed, again built from Steico's i-joist system.

However, the team spent long hours on site trying to achieve a finish with the lime that would have resembled the smooth gypsum plasterboards of the Victorian era.

Knowles says that in the end, swapping lime products was the solution. "The natural fibres used for crack resistance and thermal advantage caused the issue. A cork lime solved the problem."

However, the use of graphene-enhanced lime paint should eliminate cracking in the finish, and Knowles says this will also greatly help with long term vapour control and airtightness.

Meanwhile, Knowles is also proud of a solution he has developed that involves knocking out the front of a chimney, all the way up the three or four storeys of a typical Victorian building, to create a roomy cavity that houses all the services— including ventilation, heating and electrics.

It means that the pipes for ventilation, for instance, can be much shorter than usual, improving overall performance and avoiding the need for exposed boxing, in keeping with the original Victorian interiors.

In order to finance Ecospheric's next project — a proposed zero waste and zero energy food hall in Levenshulme — Woodleigh is currently on the market for £925,000.

The timing of this, not to mention budgets, restricted the extent of any continuous post-occupancy monitoring, which is currently fulfilled by a modest cloud-based temperature and humidity system. But Knowles says he is happy to facilitate any researchers eager to undertake more extensive study of the second property, Ingleside, which Ecospheric plan to use as its own office and show home.

But being an Enerphit Plus, the energy bills for the properties should be practically zero (see 'In detail'), and Ecospheric estimate that the water bills have been reduced from around £650 a year to £300.

Total silence & tranquillity

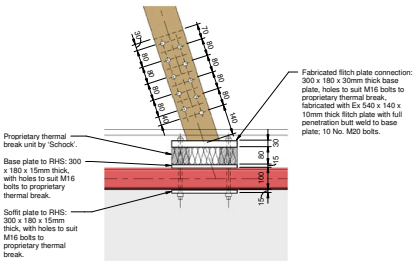
Knowles particularly likes the "crisp room shapes" and the floors in Woodleigh, which are the original pitch pine floorboards painstakingly re-laid in a chevron pattern. But above all he likes the total silence and tranquillity that descends when you step inside and shut the door behind you.

"It's really bizarre and almost everybody who is shown around the property says that there's this kind of acoustic quality about the space... like nothing else they've ever experienced. And you're in a space where, even if you get quite a lot of people, you get a crystal-clear conversation because there's so much insulation and so much thermal mass that it's just total sound absorption, which is rather unique."

Can these Zetland Road houses perhaps claim to be the greenest passive house retrofits to date in the UK, if not the world? Indeed, given their success in retaining as much as possible of the 125-year old carbon embodied in the buildings, surely Ecospheric could reasonably hold Woodleigh and Ingleside up to be among the most sustainable passive houses currently in existence, in terms of energy and materials?

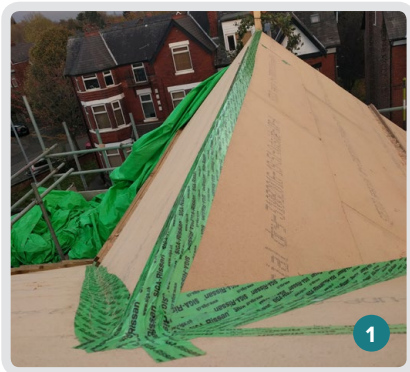
"I couldn't make that claim without more evidence," responds Knowles, but adds that he is working on a high-level carbon analysis that the firm hopes will help it make some meaningful comparisons in that regard.

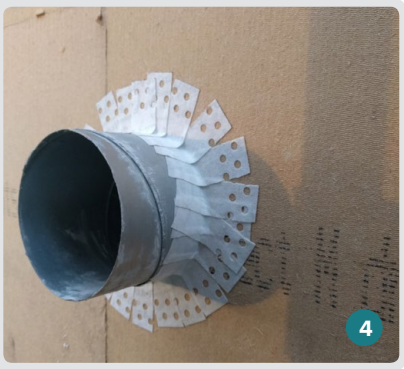
Having said that, he notes that while there are some amazingly green passive houses out there, they tend to be new-builds, they tend to be much smaller and still use a fair bit of concrete. "But for the time being all we're really willing to say is we're certainly, I think, the first petrochemical-free passive house retrofit. And I think we're one of the few passive houses that have been kind of purist to its core in terms of concrete reduction."



above Isokorb thermal breaks at both ends of a steel beam, to prevent thermal bridging where the timber A-frame is to adjoin the steel.

CONSTRUCTION IN PROGRESS





Taping of **1** the Steico Special Dry wood fibre board used to insulate the roof externally and **2** the inside of the the roof build-up internally, which features an Intello membrane here; **3** the project pioneered a solution that involved using the old chimney cavities to duct services down through the buildings; **4** airtightness taping around ventilation duct where it penetrates the Steico wood fibre insulation; **5** sealing up of the chimney cavity after the installation of services like ventilation ducting; **6** construction of aerated concrete block bench system used to support the bay windows; **7** & **8** installation & finishing details of the Viking triple-glazed aluclad windows.

> We're certainly, I think, the first petrochemical-free passive house retrofit.

SELECTED PROJECT DETAILS

Developer, contractor, project manager, M&E engineer & passive house consultant: Ecospheric
Architecture:
Guy Taylor Associates and Ecospheric
Civil & structural engineer:
Studio One Consulting
Passive house certifier:
MEAD: Energy & Architectural Design
Electrical contractor:
Environmental Building Services Ltd
Airtightness tester: Ritchie & Ritchie
Airtightness contractor:
Ecospheric and ColdProof
Wall, roof & floor insulation & build system: Steico UK
Thermal breaks: Schöck Ltd
Airtightness products:
Ecological Building Systems / Siga
Windows & doors: Viking, via Ecospheric Windows & Doors Ltd
Roof windows:
Fakro, via JJ Roofing Supplies
Organowood cladding: Ecochoice Ltd
Kitchen fit-out:
John George Fine Cabinetry
Magply: IPP Ltd
Roofing: SIG Roofing
Permeable paving: Sudstech
MVHR: Paul, via A+ Ventilation supplies
Wood burning stove: Wiking, via Woodburner Warehouse
Domestic hot water system: Mixergy
Solar PV:
Environmental Building Services Ltd
Water saving toilets:
Caroma, via Sanlamere
Water saving fittings: Bristan, via Grahams Plumber Merchant
Cast-iron bath: Cast Iron Bath Company
Paint:
Ecosphere, via the Graphene Company
Heritage lime plaster:
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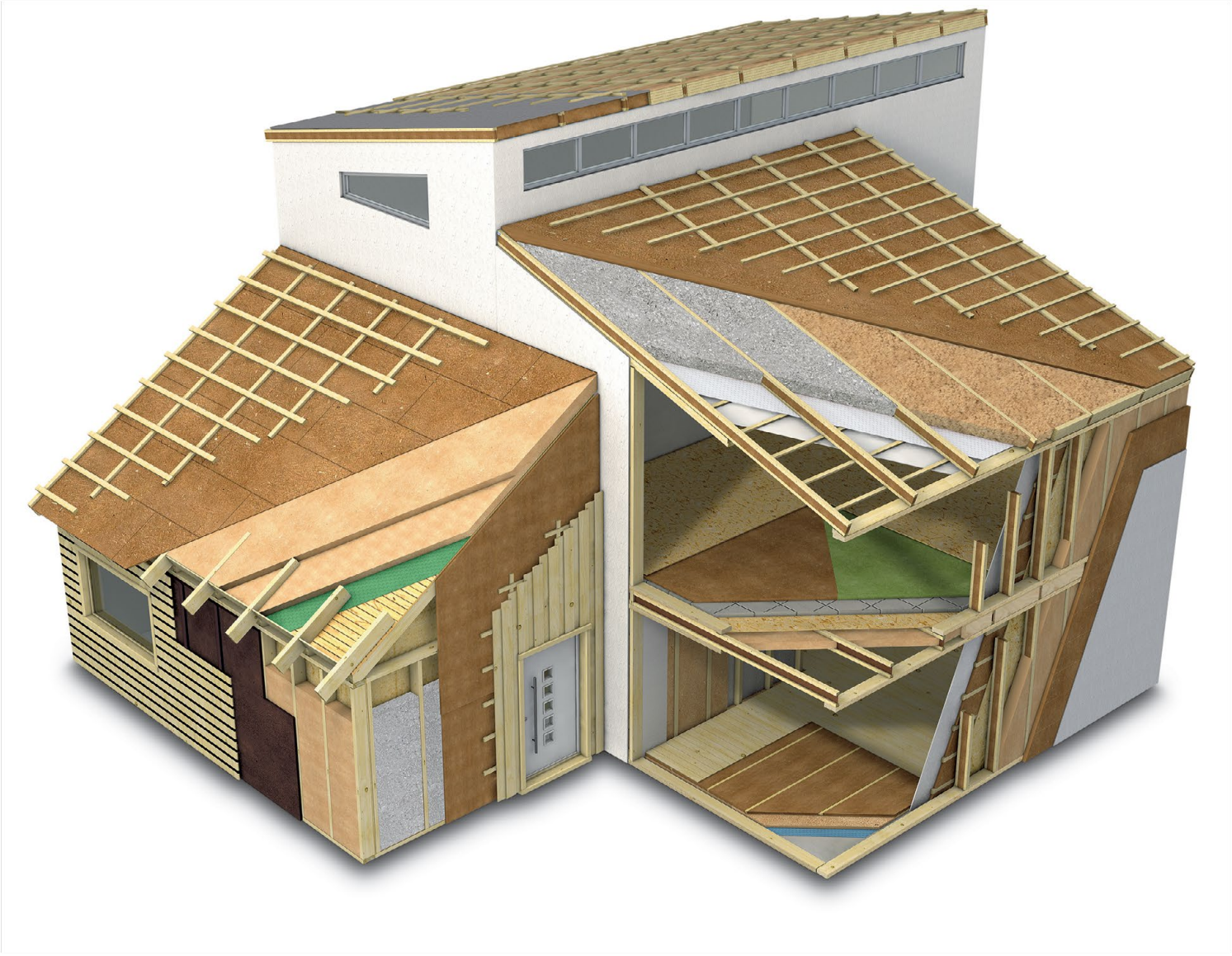

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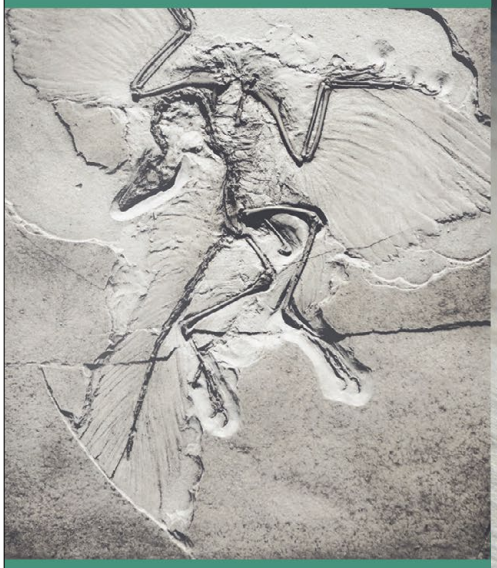

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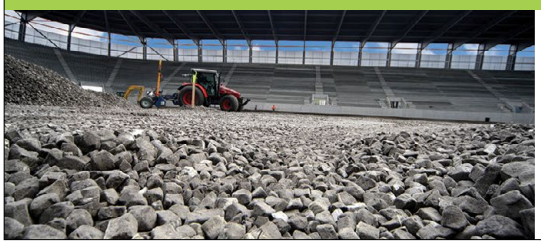

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IN DETAIL

Building type: Two Victorian semi-detached homes built in 1894, combined internal floor area of 374.3 square metres (187 square metres per house)

Location: Zetland Road, Chorlton, Manchester

Budget: £1.9 million

Certification: Enerphit Plus certified (the two combined dwellings certified as one building, party wall not thermally insulated)

Space heating demand (after):
12.5 kWh/m²/yr

Heat load (after): 10.4 W/m²

Primary energy demand (after):
99.6 kWh/m²/yr

Renewable energy demand:
41.6 kWh/m²/yr

Heat loss form factor (PHPP): 2.20

Overheating (PHPP): 0%

Energy bills (estimate, per house):
Total space heating demand of 2,346 kWh according to PHPP. This is to be met using a combination of wood burning stove & excess PV electricity to post heater in the MVHR system.

Electricity demand of 2,039 kWh per year (PHPP). To be met from solar PV system & grid electricity.

Hot Water of 1,864 kWh per year demand (PHPP). To be met from solar PV system & grid electricity.

Biomass costs approximately £80 per cubic metre for unstacked logs. Assuming this amount is burnt each year, and each cubic metre provides 1,950 kWh (2,600 kWh burnt at 75% efficiency), remaining space heating demand after logs are burnt is 396 kWh, to be provided by electric post heater to MVHR system.

Electricity consumption remaining for space heating, water heating & electrics is 4,299 kWh per year. The solar PV system generates 4,370 kwh per year, and assuming 80% utilisation & 20% export of this, the house uses 3,496 kWh solar electricity per year. This leaves 803 kWh per year required from the grid.

The house's Tonik renewable energy tariff is 12.68p per kWh plus a £73 standing charge, for an estimated annual electricity bill of £175. Adding the cost of biomass at £80, gives a total annual energy bill of £255.

However, the house receives a renewable energy feed-in-tariff of £172 + £45 for 20% PV export to grid (£217). This leaves an annual energy bill of £37. In reality one cubic metre of wood could easily be sourced for free, which would leave an annual profit on energy costs of £43.

Airtightness (at 50 Pascals):
0.9 ACH (working towards 0.6 currently)
Please note there were 20 different U-values for opaque building elements on this project and the following are just some of the main elements.

WALLS (AFTER)
Front walls: Storm dry brick cream on 110mm Victorian facing brick externally, followed inside by 38mm cavity, 13mm Fermacell board, 145mm timber I-joists fully filled with Steico floc blown cellulose, 80mm Steico Protect Dry wood fibre insulation, 10mm Thermalime plaster. U-value: 0.175 W/m²K

Side walls: 14mm Thermalime render on 80mm Steico Protect Dry externally, followed inside by 240mm Steico floc blown cellulose between Steico I-joists, 250mm double layer of Victorian wire cut bricks with finger cavity, 10mm Thermalime plaster internally.
U-value: 0.116 W/m²K

Rear walls (ground floor): Organowood cladding externally followed inside by 1mm façade membrane, 300mm timber I-joists fully filled with Steico floc blown cellulose, 1mm Proclima Intello or Siga membrane, 13mm gypsum plasterboard.
U-value: 0.132 W/m2K

Rear walls (upper floors): Organowood cladding externally followed inside by 1mm façade membrane, 300mm timber I-joists fully filled with Steico floc blown cellulose, original nine-inch brick walls, lime plaster.
U-value: 0.125 W/m²K

Floors (after): 22mm Reclaimed pine chevro with lime-based grouts & adhesives, followed below by 18mm Magply magnesium board, 1mm Proclima Intello or Siga membrane, 175mm Steico floc blown cellulose & floor joists, 80mm Steico protect dry. U-value: 0.165 W/m²K

Roof (after): Welsh slate externally on 50x35 battens/counter battens, followed underneath by 1mm breathable roofing membrane, 60mm Steico Special Dry wood fibre board, 145mm to 300mm timber I-joists fully filled with Steico floc blown cellulose, 75mm rafters fully filled with Steico floc blown cellulose, 1mm Pro Clima Intello or Siga membrane, 13mm gypsum plasterboard
U-value: 0.108-0.148 W/m²K

WINDOWS & DOORS
Before: PVC 1980's double glazing.
Overall approximate U-value: 3.0 W/m²K

After: Viking Windows AS SW14 & DK88 triple glazed timber windows: U-value of 0.68 W/m²K (uninstalled), SW14 and DK88 doors: U-value of 0.72 W/m²K (uninstalled)

Roof windows: Fakro U8 thermally broken triple glazed roof windows with thermally broken timber frames.
Overall U-value: 0.81 W/m²K

HEATING SYSTEM
Before: Gas boilers and radiators
After: 2kW electric post heater on Paul Novus 300 MVHR system, DiBT accredited Wiking log burning stove. Domestic hot water electrically heated in Mixergy 300L tank. Electricity fed from PV on roof.

VENTILATION
Before: No ventilation system.
After: Paul Novus 300 heat recovery ventilation system. 93-94% heat recovery (PHI certified)

Green materials: Wood fibre and cellulose (recycled newspaper) insulation; lime plaster/ render; timber frame hybrid construction; breathable magnesium construction boards; breathable flooring materials: Tuscan marble, hardwood; copper detailing for ultra-durable rainwater and coping goods; FSC certified hardwood cabinetry; Welsh slate kitchen worktops; CO2 absorbent lime-graphene paint by Graphenstone.

Electricity: 60 square metre solar PV array across the two properties. Comprising 36 x 330-Watt Panasonic HIT modules over two systems. Each system being 18 modules, and with each module having a Tigo voltage optimiser connected to efficiently manage any shading effects, and to maximise the total output of the systems. The total installed capacity is 11.88kWp. Each 18-module system has been wired in two strings, one string of 11 modules (3.63kWp) and one string of 7 modules (2.31kWp). This configuration is to allow the later addition of on-site energy storage. A Solar IBoost water heater controller is also installed on each system. These controllers monitor the electricity consumption in the house and as soon as any of the PV generated electricity is not being used and begins to export, this PV electricity will be diverted into a circuit of choice. In Zetland Road this circuit of choice is an immersion heater in the hot water cylinder. As the two houses consume so little electrical energy, a large proportion of domestic hot water will be generated from using PV electricity.

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£77

per year for space heating & hot water (not including VAT or standing charges)

Building: 110 sqm detached mews house

Location: Camberwell, South London

Completed: November 2017

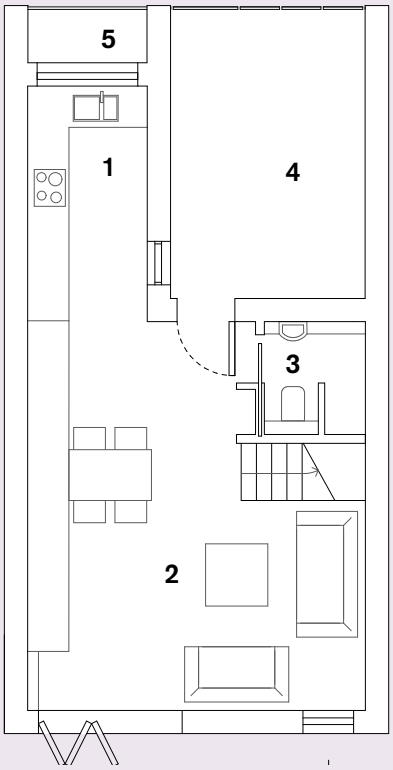
Budget: £245,000

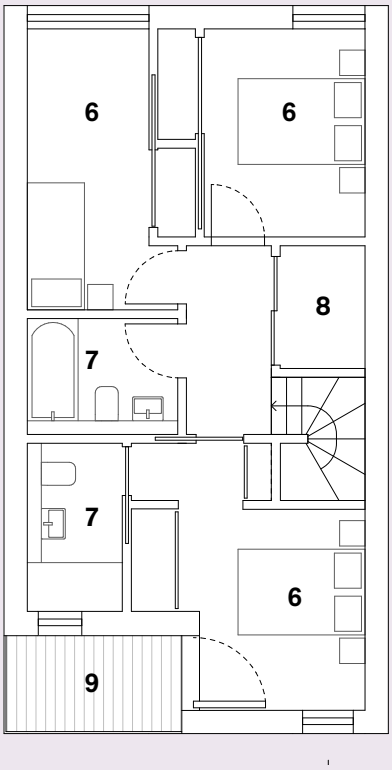
Standard: Passive house certified

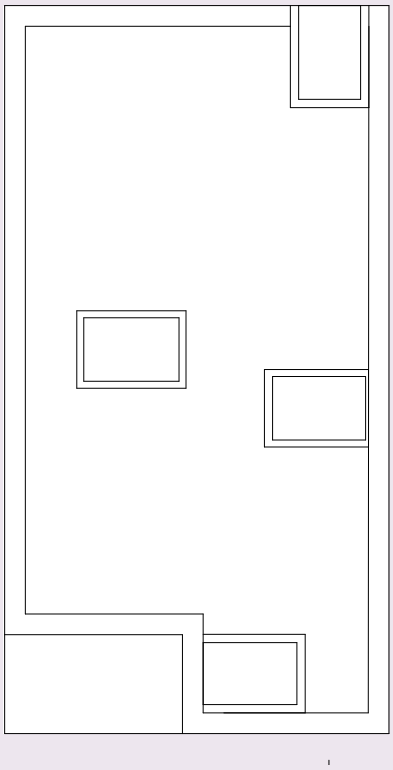
A PASSIVE MEWS
FIT FOR A PHYSIO

This beautifully designed passive house showcases some of the very best in contemporary urban architecture, responding thoughtfully to its historic surroundings while making ultra-intelligent use of space to create an airy, warm and light-filled home on a small mews site in South London.

Words by David W Smith







1 Kitchen
2 Living Room
3 Toilet / Utility

4 Garage
5 Bin Storage
6 Bedroom

7 Bathroom
8 Plant Room
9 Terrace

Elizabeth Sharp, one of the UK's most renowned physiotherapists, was initially worried she would struggle to make the transition from a vast four-storey Georgian house to the small open-plan passive house she had built in her garden in Camberwell, South London.

But the move proved surprisingly easy as she instantly enjoyed the new house's more manageable space (110 square metres), passive house comfort, and lack of clutter. The judges of the Daily Telegraph's Homebuilding and Renovating competition were equally enthusiastic, awarding it the prize for the Best Green House 2018. It was also recently nominated for a Passivhaus Trust award.

"It was a huge lifestyle change as I had always lived in old houses. I'd been in the Georgian house for 40 years and brought up my three sons there. I could also still see it out of the window, so I expected memories to come flooding back. But, to my immense surprise, I felt so comfortable in the new house I didn't miss the old one at all," she says.

The reality was that Elizabeth, 76, had grown tired of living in such a large, uneconomical space. Although suitable for bringing up a family, it had always leaked energy and had high bills.

"The heating was just flying straight out the window and the entire top floor of the house was unused because I didn't need the space. In my new house, my annual energy bills are around £300 and in summer I can open the roof lights and windows at the front and back to create a lovely draught," she said.

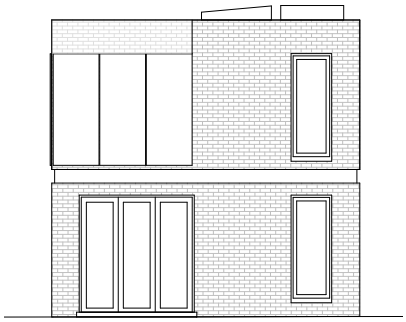
There was a great deal of relief when Elizabeth finally moved into the Mews house this year. The build was initially supposed to take a year but was delayed by four months when the building contractor went bust halfway through and had to be replaced at short notice. It was a worrying time as Elizabeth had taken out a bridging loan to cover the cost of the new house while she tried to sell her old one.

Fortunately, Elizabeth's son Alexei, a former international decathlete, came up with a solution. He was already project managing the construction of the new house and he took the opportunity to set up his own construction company, then re-employ the team of Polish builders already working on the project. Everything fell into place. The project was completed, and Elizabeth found a buyer for her Georgian house. "I was anxious when I had to sack the contractor and I lost money over it but looking back I'm so happy here now that I forget the bad things and look to the future," she says.

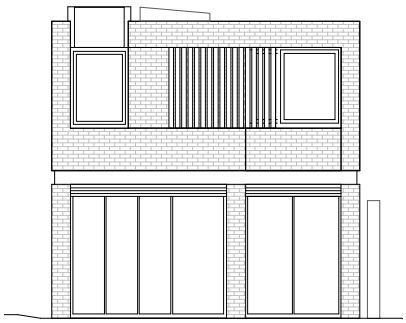
Downsizing will enable Elizabeth to retire in comfort, but for now she is still clinical director of leading health, fitness and physiotherapy firm ESPH — together with her sons and co-directors Max and Alexei Sharp — and works mainly at EPSH Harley Street, the longest-serving physiotherapy practice on London's medical mile. She's worked with Arsenal football players, the stars of big London shows such as Cats and Midnight Express, and many well-known athletes.

For 25 years, Elizabeth ran a physiotherapy business out of the basement of her old Georgian home, but eventually the workload became too large for the space and in 2007 the business moved to a 10,000 square foot Victorian property in East Dulwich, which was converted by RDA Architects into a complete fitness centre including a creche, large gym, physio rooms, Pilates studio and yoga facilities.

But once the physio business had moved out, and her sons had grown up, Elizabeth no longer needed such a big house. However, she'd lived in the area for 40 years and wanted to stay local. She approached RDA again for advice on downsizing, because, she says, they had done a great job on her East Dulwich development. RDA chief Richard Dudzicki proposed a three-bedroom passive house on the site of the previous garage in the garden and promised her it would be warm, economical and full of light. She gave



North - East Elevation



South - West Elevation

> The tight space required a lot of ingenious thinking.

the go-ahead on condition that she could include a hydrotherapy pool in the garden.

It was RDA's fourth certified passive house, and one of the others was actually a few doors down on the same street. But Elizabeth's project presented certain challenges, including the difficulty of access to the Mews location, a tight budget of £245,000, and a restricted space of around five-by-eight metres.

One by one, Dudzicki and his team found a way to resolve the issues. The tight space required a lot of ingenious thinking. Every component was designed to be "like the inside of an aircraft so it all fits neatly and has more than one function". The stainless-steel kitchen table, for example, slots into the kitchen units, and can be pulled out when dinner is served. The living room's furniture was adapted from compact kitchen units, but it was custom-made. The television is hidden away and the space for the wheelie bins sits just outside the kitchen window, where it is invisible from the street.

The house is also designed with an opening for a staircase lift. Meanwhile, the space under the stairs is used as a laundry room and the MVHR [mechanical ventilation with heat recovery] unit is tucked away in the cupboards at the top of the stairs. "Everything comes into one plant which acts as an essential node to shorten distances for all the duct work and save money. Lots of details were about saving on the budget as well as making the house as multi-functional as possible," Dudzicki says.

The deep plan necessitated more ingenuity to get enough light into the middle of the long and narrow house. At the front of the building the team placed a window that rises above ceiling height, bringing light into the depth of the room. In the middle of the building, they added a flat roof light above the stairs. Meanwhile, a light in the central bathroom brings in yet more sunlight.

One of the loveliest design touches, which Elizabeth describes as her "gem", is the pool in the garden. It is covered in decking, which slides open like a scene from Thunderbirds. "Everyone was aghast when I said I wanted the pool, including the architects. But exercise is so important to me as a physio and it's the jewel in the crown for me. It's an 'endless pool' with a jet stream, which allows me to convert a small space into what is effectively like an Olympic pool. It also has an in-water treadmill. It suits the style of the house perfectly," she says.

The electricity demand to power the pool is comfortably covered by the house's solar PV array, and while the pool is heated electrically too, the architects insulated it heavily to minimise heat loss.

The site's inaccessibility posed further problems, though. The house sits on an unmade road that has two 90-degree bends. The Kingspan TEK structural insulated panels (SIPs) used to construct the walls and roof had to be brought down the laneway in vans because a larger lorry wouldn't fit.

RDA designed the panels to be no larger than three-by-two metres, so they could be transported more easily. Fortunately, some neighbours allowed the builders to use their car park and even take down a fence for access. Once the prefabricated panels arrived on site, the construction process was rapid. "It took around three months to put in the foundations, but then the house itself went up in three weeks. Using the SIPs panels, we put up the floors very quickly and the rest of the time was spent fitting it out with cladding and putting the windows in," says Dudzicki.

> The architects also designed the house to run at a slightly hotter temperature than normal.

Planning permission was achieved easily. But the planners insisted on a slightly industrial aesthetic in keeping with road's historical use for back garages. Using bricks would have raised the budget, but the planners allowed Dudzicki's team to stick 15mm brick slips onto the top of the panels. Designing with timber and aluminium for some parts of the house added to the industrial look. Off-street parking was not allowed so the architects designed a garage for an electric car complete with charging points. In keeping with the multi-functional style of the house, the garage can become an open courtyard when the panels are slid back.

RDA trained the builders in passive house construction on site, including in the principles of airtight building. An early test air test showed great promise with an air permeability result of 0.54 ($m^3/hr/m^2$).

Due to the unintentional use of an inferior airtightness tape around the windows, the house failed dramatically on its second test, but once the correct tape was installed the house scored 0.61 on its third test. On its final

Photography: Simon Maxwell & Timothy Soar

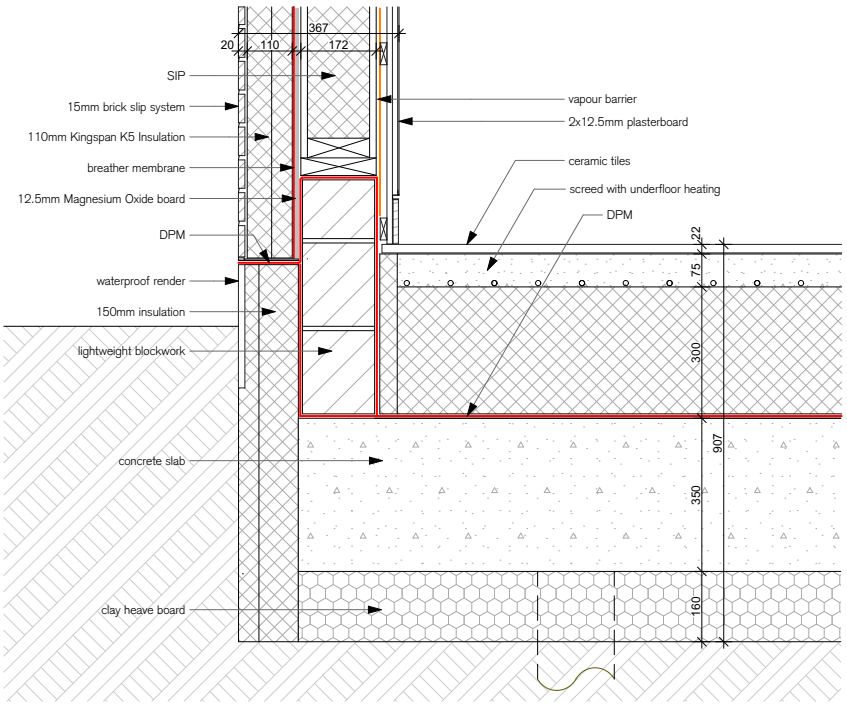
> Everyone was aghast when I said I wanted the pool, including the architects. But exercise is so important to me as a physio.

test, it achieved 0.43 (or 0.49 air changes per hour, better than the passive house standard of 0.6).

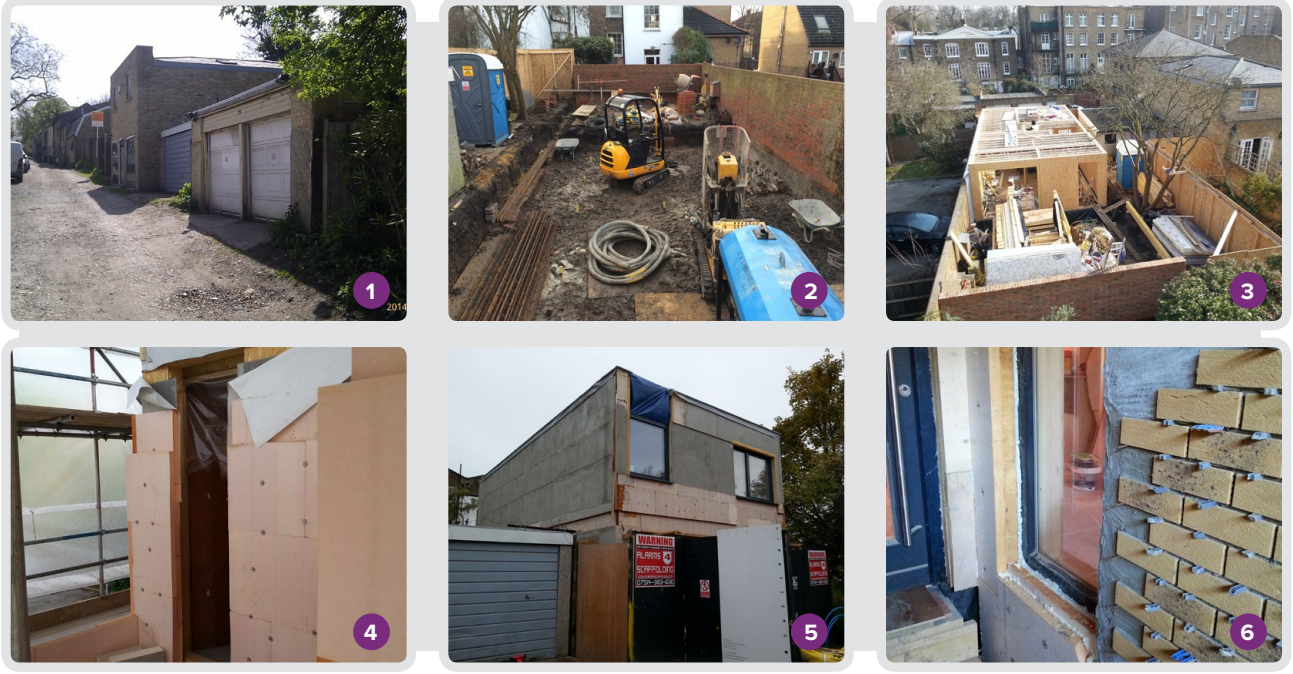
The architects also designed the house to run at a slightly hotter temperature than normal. Rather than the normal 21C, they aimed for 23C because Elizabeth wanted a particularly warm home. At times over the scorching summer of 2018, the monitored temperature inside went up above 25C. On 22 and 23 July, it reached 27C in the house when the outside temperature was 35C, and 33C respectively. However, this was during a period when Elizabeth was away, the ventilation system was turned off, and windows were left closed.

"It's slightly above the curve for London temperature data for PHPP, but it's still okay. Elizabeth likes to keep all the windows open in summer and she can do night-time cooling," says Dudzicki.

Elizabeth also wanted underfloor heating, fearing the house might not be warm enough in winter. She needn't have worried. "They told me I would need no more than two radiators and I said, 'you don't know me, I really feel the cold'. I've not used it much but when there was snow and minus temperatures it was lovely to walk around barefoot on the warm ceramic and vinyl tiles," she says. "It's another of the many features I love about the house."



CONSTRUCTION IN PROGRESS



1 The mews lane, which has another certified passive house by RDA Architects a few doors down the street; **2** construction work begins on the foundations which took around three months to complete; **3** the house itself then went up in three weeks using Kingspan TEK structural insulated panels; **4** 110mm Kingspan K5 Kooltherm external phenolic insulation board was fitted externally to the panels to further boost the U-value of the walls; **5** the house nearing completion; **6** adhesive applied to the insulation boards for adhering the 15mm brick slips to the wall.

SELECTED PROJECT DETAILS

Client: Elizabeth Sharp
Architect / M&E engineer: RDA Architects
Build system supplier: Kingspan TEK
Passive house certifier: MEAD Consulting
Civil & structural engineer: Elite Designers
Main contractor: CLC Build
Quantity surveyor (preliminary advice): Burr & Neve
MVHR system: Paul, via Green Building Store
Airtightness test: EPS Group
Insulation: Kingspan Insulation UK
Airtightness products: Ecological Building Systems
Windows & doors: Livingwood Windows
Roof lights: Fakro
Kitchen & storage: Comprex
Roofing membrane: SIG
Floor tiles: Feri & Masi
Gas boiler: Vaillant
Underfloor heating: Omnie
Solar PV: Energy Cycle

A ***structural insulated panel (SIP)*** consists of a layer of insulation, usually a synthetic foam insulant, sandwiched between two layers of oriented strand board (OSB), providing both building structure and insulation in one pre-fabricated panel.

Airtightness is typically measured in two ways: air changes per hour (ACH) or air permeability ($m^3/hr/m^2$). During a test a building is normally pressurised at 50 Pascals of pressure (50pa). ACH measures the number of times in an hour leaks in the building envelope allow its entire volume of air to be changed with external air. The passive house standard requires an ACH of 0.6 or less. Air permeability measures the volume of air (in metres cubed, m3) that can be pushed through gaps in one square metre of the building envelope per hour under pressure. For most typical houses the two figures are usually quite similar, but they start to diverge as building gets bigger, or if they have more complex shapes.

> The judges of the Daily Telegraph's Homebuilding and Renovating competition were equally enthusiastic, awarding it the prize for the Best Green House 2018.

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IN DETAIL

Building type:
Detached 110 square metre mews house

Location: Camberwell, London

Completed: November 2017

Budget: £245,000

Space heating demand (PHPP):
15 kWh/m²/yr

Heat load (PHPP): 9.5 W/m²

Heat loss form factor (PHPP): 3.97

Overheating (PHPP): 5.8%

Primary energy demand (PHPP):
48 kWh/m²/yr

Energy performance certificate (EPC):
A (90)

Airtightness (at 50 Pascals): 0.43 m³/hr/m² or 0.49 air changes per hour

Energy bills: Elizabeth's estimate of her own combined annual heating & electricity bill is £300 per year. Passive House Plus's estimate of her gas bill for heating & hot water is £76.85 per year, not including VAT or standing charges, factoring in the heating demand (PHPP), floor area, boiler efficiency and an estimated gas price of 4.2c per kWh.

Ground floor: Ceramic tile finish, on 75mm screed with underfloor heating, on 300mm Kingspan Thermafloor TF70 PIR insulation board, on liquid applied damp proof membrane, on 350mm reinforced concrete slab, on 1,200-gauge polythene membrane, on Cellcore HXS 160mm, on 50mm binding to compacted hardcore base.
U-value: 0.07 W/m²K

Walls: 15mm brick slips externally, followed inside by 110mm Kingspan K5 Kooltherm external phenolic insulation board, breather membrane, magnesium oxide board, 172 Kingspan TEK structural insulated panel system (comprising urethane insulation core sandwiched between two layers of OSB3), vapour control layer, 25mm service void, 2 x 12.5mm FireLine plasterboard, skim plaster finish. U-value: 0.075 W/m²K

Roof: Singly ply roof membrane externally, followed beneath by 18mm plywood decking, min 50mm void, 172 Kingspan TEK SIPs panel (as above), 120mm Kingspan Thermapitch TP10 PIR insulation board, vapour control layer, 185mm void, 2 x 12.5mm Gyproc Wallboard, 3mm smooth plaster skim finish. U-value: 0.08 W/m²K

Windows & doors: Livingwood Windows

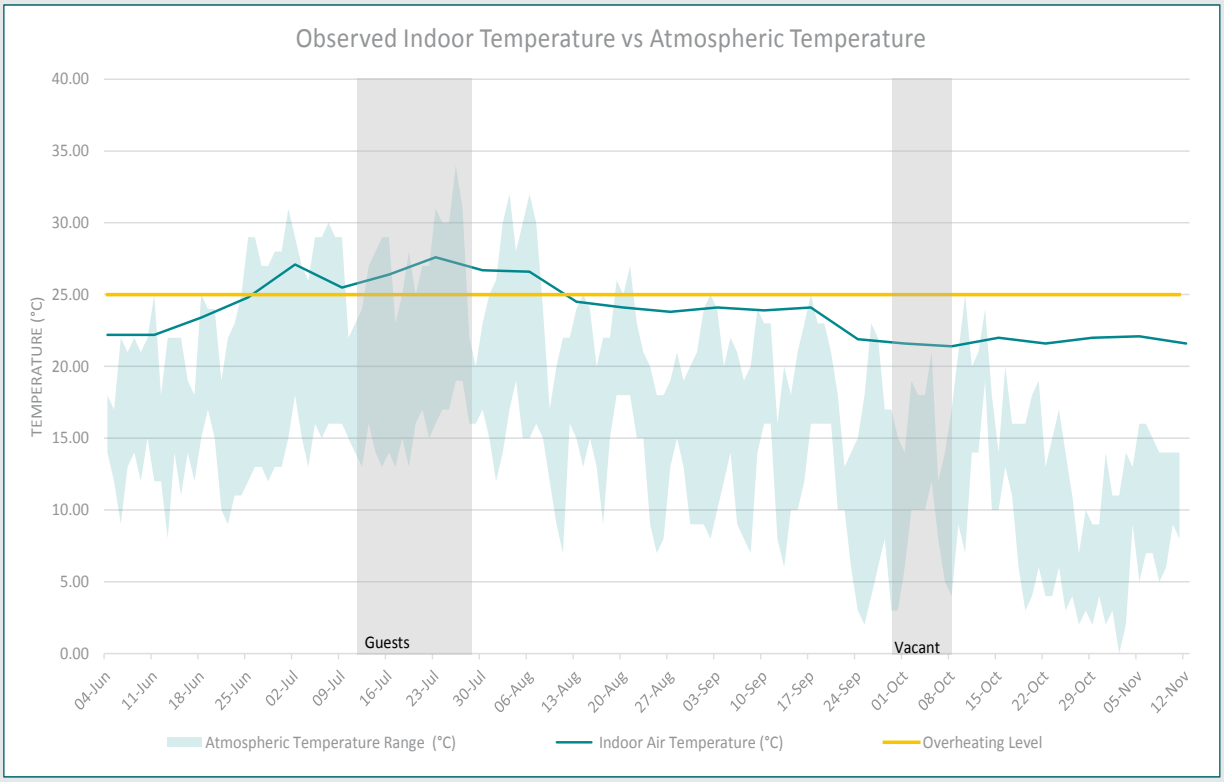
passive house 3k alu-clad triple glazed PHI certified windows. overall U-value: 0.66 W/m2K. Also, Livingwood 14 passive house outward opening casement with overall U-value of 0.68 W/m2K. Bi-fold Door: Lacuna heat treated beech triple glazed bi-fold door; U-value: 0.95W/m2K. Livingwood Windows 3k alu-clad fully glazed entrance door; U-value: 0.72W/m²K

Roof windows: Fakro U6 thermally broken triple glazed roof windows with thermally broken timber frames.
Overall U-value: 0.81 W/m²K

Heating system: Omnie underfloor heating system powered by a Vaillant Ecotec Pro 24 kW condensing gas combi boiler.

Ventilation: Paul Focus 200 MVHR system, PHI certified heat recovery rate of 91%

Electricity: 6.7m2 solar photovoltaic array with average annual output of 945 kWh/a



GOOD MEWS STORY

IN DÚN LAOGHAIRE

An award-winning social housing development in South Dublin points to a sustainable way out of Ireland's housing crisis.

Words by Jason Walsh

Building: Four 55 square metre apartments
Location: Sallynoggin, Dún Laoghaire, Dublin
Completed: December 2017
Standard: Nearly zero energy building (nZEB)
Energy bills: Unavailable – monitoring underway

> It was intentionally a very simple design that any contractor could replicate.

The architects' department in Dún Laoghaire-Rathdown County Council has done something impressive: by building The Mews in Sallynoggin, a development of four apartments, it has proved that, even in the midst of a housing crisis, we are capable of building homes that are sustainable, comfortable and healthy.

That they are also social housing only strengthens the case.

Unfairly, local authority building projects tend to be the poor cousin when it comes to reporting on construction and development.

Of course, this is not surprising: much architecture coverage, particularly in popular media, focuses on either giant buildings by 'starchitects' or else Grand Designs-like one-off houses. Neither is without merit, and ideas do cross pollinate, but neither corporate headquarters nor flashy one-off houses are the be-all and end-all of architecture.

Dún Laoghaire-Rathdown has long been noted as one of the more progressive local authorities in Ireland, both in terms of sustainability and social housing. It was one of the first councils to adopt its own tougher building energy standards locally, back in 2007. Then in 2016, the council introduced a rule that all new homes in the district must be to "passive house or equivalent" standards.

Local authority architect Joanne Maher says that while energy conservation is central to it, the core mission of sustainability is a wider issue, and one that she tries to build into her own work. This includes environmental concerns, but also wider social issues.

"What we were trying to achieve was a social as well as environmental build, [and] what the RIAI [Royal Institute of the Architects of Ireland] felt was that the scheme could be easily replicated, but also [that it] addressed two issues: how to increase housing supply and also what to do

WANT TO KNOW MORE?

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The digital magazine is available to subscribers on www.passive.ie

about our existing low-density suburbs."

The RIAI's interest was not just a case of a nice notice: The Mews won the sustainability category at the 2018 RIAI Architecture Awards.

The Mews blitzes Ireland's incoming nearly zero energy building (nZEB) standard (see 'nZEB? No problem'), with all the units achieving A1 building energy ratings. And while it did not aim for passive house certification, the spec is for insulation, thermal bridging, airtightness and ventilation — along with the building's comparatively simple, compact form and sensible glazing levels — are straight out of the passive house playbook.

Indeed, one of the primary design goals at The Mews was to keep things simple, using traditional cavity wall construction with a strip foundation, for a start.

According to Maher, this was done in order to develop a form of building that does not require massive amounts of re-training for tradespeople on site. "It was intentionally a very simple design that any contractor could replicate," she says.

"It was full-fill cavity insulation; it's a straightforward, known system, and because of the compact shape we didn't have any thermal bridging." The team used Cavalok BigBlok cavity closers during the build, which provide a frame in window and door openings around which blocks can be laid, while simultaneously sealing up cavities up to 300m wide.

Issues such as passive solar gain were also considered.

"The building has a 170 square metre footprint [so] it's quite dense, but in its shape and orientation it's very simple: it's a rectangular block with the main orientation to the southwest, with the glazing facing that way and very small windows to the northeast," Maher says.

"We always think about things like solar gain and loss and cross ventilation."

In terms of buildings services, there is a small Dimplex heat pump generating hot water, and a heat recovery ventilation system. Space heating is provided by four radiant Dimplex electric panels in each apartment, while four solar photovoltaic panels on the roof help to meet electricity demand.

Dún Laoghaire-Rathdown County Council is currently in the early stages of monitoring temperature, humidity and indoor air quality in the dwellings.

This design simplicity also appears to have paid-off in more ways than simply impressing the majordomos at the RIAI. As a result, The Mews is as much a model for the future as it is a social housing development.

"One thing we were trying to show was that you can achieve airtightness through good detailing and good energy performance through materials, but do so with what was a typical build: we wanted to keep things to a

> The Mews is as much a model for the future as it is a social housing development.

nZEB? No problem

The apartments at the Mews qualify as nearly zero energy buildings (nZEBs) because of their remarkably low energy & carbon performance coefficients (EPC & CPCs) in Deap, the software used in Ireland to calculate building energy ratings (BERs) and verify compliance with Part L of the building regulations. Both the EPC and CPC are overall scores that take into account a wide range of energy efficiency factors like insulation, airtightness, the efficiency of heating systems and any renewable energy systems.

Under EU rules, all new homes must be nZEBs from the 31st December 2020, though each country has certain freedom to define their own nZEB standard. In Ireland, under the new version of Part L for homes set to come into force next year, dwellings must have maximum EPCs and CPCs of 0.3 and 0.35 respectively to meet nZEB. With EPCs and CPCs of around 0.1, the apartments at The Mews easily beat these targets.

simple way," says Maher.

The construction process itself – oftentimes ground zero for conflict – was also smooth, she says, with a wry joke.

"The build went very well. Everyone was talking to each other at the end, which was really good.

"The contractor hadn't any experience with passive house or what we were trying to achieve but they were very willing to learn and ready to take it on board. We were very lucky with them," she says.

Maher strikes a pragmatic note, saying that while new techniques are always welcome, a path of least resistance can also be used to produce sustainability – if the design is right.

"No-one is really interested in going out and spending money and learning if they don't have to. We also had to work within a budget."

In a way the apartments are modest enough: clean and modern in design rather than proffering the 'shock of the new', and intended to belong to the community in a general sense of not being jarring.

This is perhaps the greatest success of The Mews and its designers, though: by thinking in terms of social need Maher and her colleagues were able to create a repeat-able scheme that, if widely applied, could go some way to both easing the ongoing housing crisis and also improving the overall Irish housing stock.

Built on a garden site, the building also seeks to address the issue of low density in the south Dublin suburb. As it is suitable for elderly or less abled inhabitants it has a further social function in that it promotes continuity and cohesion.

"It allowed the residents to stay in their locality, rather than have to move out," she says.

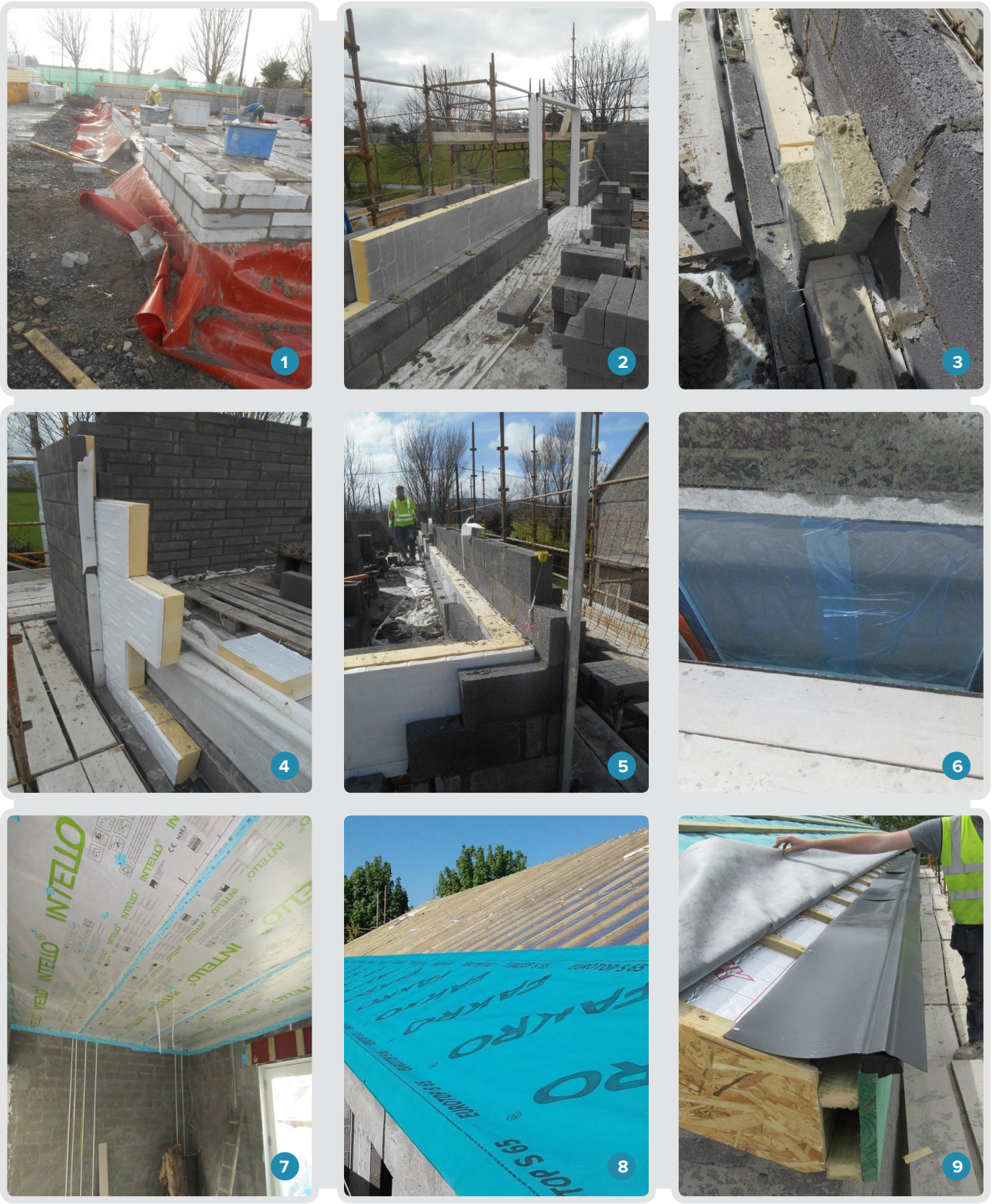
The bottom two units are wheelchair accessible, and all four units feature braille signage, with the designers and council recognising that they needed to think about the occupier in the broadest possible terms: the goal was to give them freedom, Maher says.

"We never know who's going to use a unit. It was important, for instance, to have turning circles and allow it to be completely open and accessible, and to use materials that were neutral to allow people to put their own stamp on it at as home."

> "It allowed the residents to stay in their locality, rather than have to move.

Photography: Donal Murphy

CONSTRUCTION IN PROGRESS

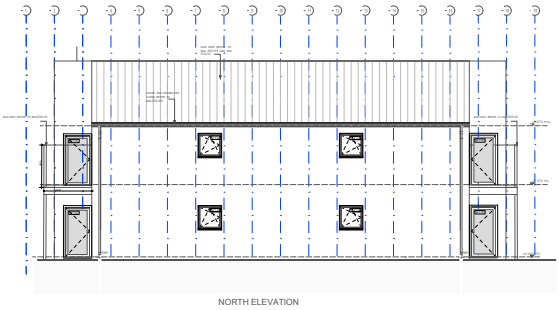


1 The ground floor features several courses of Quinn Lite AAC blocks to minimise thermal bridging, plus a radon barrier; **2** Cavalok BigBlok cavity closers provide a thermally broken frame in window and door openings around which blocks can be laid, while simultaneously sealing up the wall cavities; **3**, **4** & **5** the build is traditional cavity wall construction, with full-fill Xtratherm Cavitytherm rigid PIR insulation, a method chosen for its simplicity and repeatability; **6** installation of the triple-glazed Rationel aluclad windows; **7** Intello vapour control layer installed at ceiling level with airtightness taping at seams, where it meets the wall, and at cable penetrations; **8** the Fakro Eurotop S65 breather membrane protects the roof structure against moisture; **9** Xtratherm insulation installed over roof afters under the membrane. **(opposite, top right & bottom right)** Dimplex EDEL hot water heat pump integrated in 200 litre domestic hot water Tank & Xpelair Xcell 150QV MVHR System.

SELECTED PROJECT DETAILS

Client: Dún Laoghaire – Rathdown County Council
Architects: Dún Laoghaire – Rathdown County Council Architects' Department (clerk of works, Aidan Shannon; project architect, Joanne Maher; county architect, Andree Dargan)
Contractor: Bracegrade Ltd
Health & safety: Scott & MacNeill
Quantity surveyor: Nolan Construction Consultants
Mechanical & electrical engineer: Delap & Waller
Assigned certifier / civil & structural engineer: Punch Consulting Engineers
BER assessor: Geraghty Energy Consultants
Fire consultant: John McCarthy
Airtightness consultant: IHER Energy Services
Airtightness tester: Evolved Energy Solutions
Airtightness products: Ecological Building Systems / Siga
Thermal breaks: Schöck, via Contech
Thermal blocks: Quinn Building Products
Wall & roof insulation: Xtratherm
Windows: Rationel
Landscaping: MCD Landscapes


THE MEWS
AN EACHLAN



IN DETAIL

Building type:
Scheme of 4 x 55 sqm social housing units

Location: Sallynoggin, Dún Laoghaire, Dublin

Completion date: December 2017

Budget: €800,000 approx (excluding Vat)

Passive house certification: Not assessed

Note: Figures are for one upstairs & one downstairs unit

Space heating demand (DEAP):
6.5 kWh/m²/yr (upstairs unit).

Primary energy demand (DEAP): 14.6 & 21.1 kWh/m²/yr (note: does not include plug loads)

Heat loss form factor (DEAP): 2.45 & 2.8

Energy performance coefficient (EPC):
0.109 & 0.109

Carbon performance coefficient (CPC):
0.105 & 0.105

BER:
A1 (14.6 kWh/m²/yr) & A1 (21.10 kWh/m²/yr)

Measured energy consumption:
Currently being monitored

Airtightness (at 50 Pascals):
0.94 m³/hr/m² & 1.0 m³/hr/m²

Thermal bridging: Several courses of Quinn Lite AAC blocks at and above subfloor; Cavalok BigBlok cavity closers; Isokorb thermal breaks at balconies.
Y-value of 0.08 W/m²K used – as per Acceptable Construction Details.

Energy bills: Unavailable

Ground floor: Screed on Xtratherm XT/UF rigid PIR insulation, on radon membrane, on precast concrete slab. U-value: 54.74 W/m²K. Strip foundation to perimeter of building.

Walls: External render on concrete block, on full-fill Xtratherm Cavitytherm rigid PIR insulation, on concrete block. U-value: 0.15 W/m²K. Quinn Lite thermal blocks to base of walls.

Roof: Pitched roof with Roadstone SL8 slate grey roof tiles externally, followed beneath by batten space, breather membrane, 75mm/100mm Xtratherm XO over rafters, 100m XtroLiner XO between rafters, vapour control layer, plasterboard.
U-value: 0.13/0.11 W/m²K

Windows: Triple glazed Rationel aluclad argon-filled windows. Overall U-value: 0.79 to 0.82 W/m²K

Heating system: Direct electric heating via Dimplex radiant electric heating panels, Dimplex EDEL hot water heat pump integrated in 200 litre domestic hot water tank, with co-efficient of performance of 3.43 (EN16147) and heat loss rate from cylinder of 1.85 kW per 24 hours.

Ventilation: Xpelair Xcell 150QV MVHR system with 89% heat recovery efficiency.

Electricity: 4 x Dimplex 300Wp solar PV panels with total electrical contribution of 980.16 kWh per year per dwelling (DEAP).

WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie

HOLY TRINITY

Situated in a stunning location in the west of Ireland, between Galway Bay and the limestone hills of the Burren, this project provided a complex challenge in three parts: deep retrofit an old cottage into a yoga studio, reinvigorate its original extension, and build a new barrel-roofed passive-grade extension — then make it all work together as one unified home and workspace.

Words by Jason Walsh

Homeowners Keith & Amanda Horan

€700

estimate for space heating

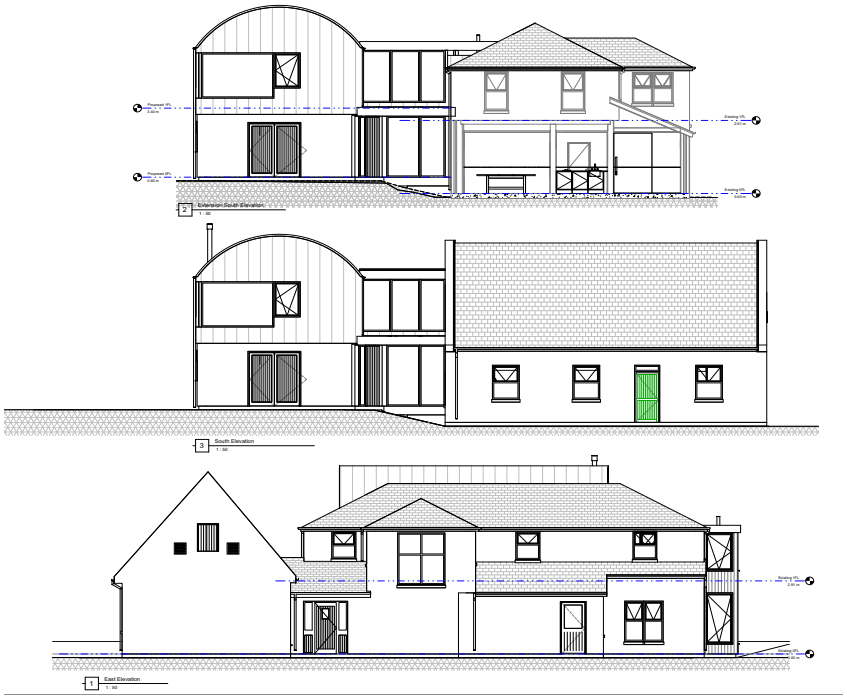
(see 'In detail' panel for more)

Building:
424 sqm home, office & yoga studio, in three sections

Location: Kinvara, Co Galway

Completed: August 2017

Standard:
Passive-spec extension, deep retrofit to old cottage



When Amanda and Keith Horan wanted to extend their existing, partially upgraded, cottage near Kinvara, County Galway, they knew they wanted a sustainable building from day one, but their goals were not going to be easy to satisfy. They needed a family home, workspace and a yoga studio, and had three buildings to integrate into the plan — the old cottage, a nine-year old extension, and a large new extension that would be built to a passive house specification.

"My wife is a yoga teacher and I'm a mindfulness teacher," says Keith Horan. The house as it stood—a traditional Irish cottage with a modern extension — already had a small yoga studio, but space was tight. This time, the plan would be to turn the old cottage into a full yoga studio.

"Originally when we moved here, it was in 2005. There was an existing extension and we finished it: the walls were up but that was all. I was a secondary school teacher and Amanda was a yoga teacher [so] we built a small [yoga] space even back then. It was fine, it was a nice room, but now it's a lot better," he says.

The Horans engaged architect Miles Sampson to produce a design for the three structures. "We were ecologically-minded but we didn't really know how to go about it. It was then seeing Miles's website that drew us in," he says.

The end result has been a very positive one for the family.

"We've really learned a lot working with Miles. He jumped out: he was the first person I contacted, we had an initial meeting and that was that—we didn't consider anyone else. He completely understands what he's doing." Horan says that, after discussions with Sampson, the brief was to create a space that was not only appropriately warm, but also full of light.

"You're looking for a space that connects to the outside: lots of natural light, comfortable, with good air, warm, using natural materials as much as possible. We had a vague idea of what we were looking for, but Miles crystallised it," he says.

Meanwhile, the contractor on the project was GreenTec Building, led by Niall Dolan, with foreman John Forde running the project on site. Sampson has now worked with GreenTec on numerous passive houses around the west of Ireland.

Sampson explains that the three buildings that now comprise the finished home-and-workplace each has its own character — and needs.

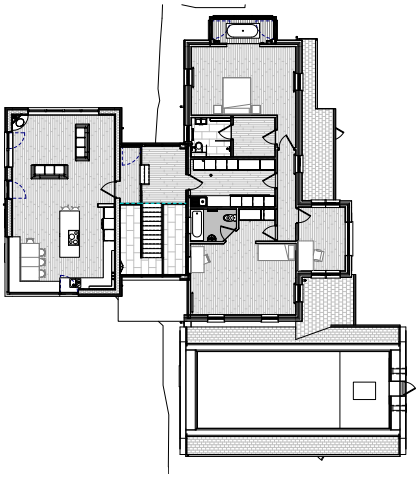
"Basically, there are three elements: the entirely new barrel-roof element, the previous extension, which is nine years old, and the cottage, which goes back a hundred years or so but had been renovated," he says.

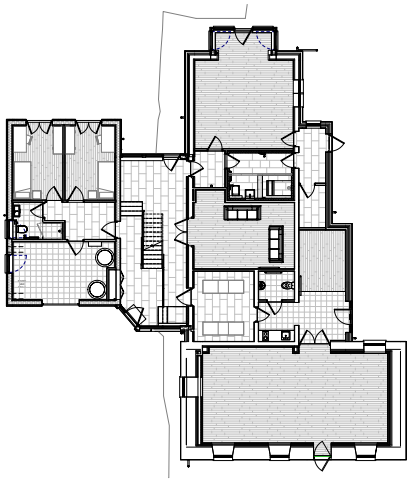
The dwelling, in three discrete but interlinked parts, now consists of five bedrooms, with two on the ground floor of the new extension, and three in the old extension. The old extension also includes a den for the couple's children, plus an office. The cottage has been turned over to use as the yoga studio.

"The [new] extension gives a feeling of fitting in the landscape. It has a familiar air with a barn-style roof, but it also has living space on the first floor, giving as much space as possible and, hence, a lot of light. With an A-roof you'd not be able to get the same amount of space."

Sampson says that with renovation work, a big part of the job is working with what is reasonable. "In the [new] extension, the performance is very much to passive standards, so everything on the extension is to the highest standard. Often, in a situation where we're extending, we bring up the existing house to a very high standard too, but the previous renovations were only done nine years before, so it didn't make sense to pull it apart. We did put in a heat recovery ventilation system [in the original extension]."

Some draft-proofing work was also carried out on this part of the building to improve its airtightness too. Meanwhile the old cottage had previously been insulated





internally with some drylining, but as it was set to be reconfigured into a yoga studio, the opportunity was taken to thermally upgrade the fabric further, fitting it out internally with sheep wool insulation and vapour control membranes – with a barrel vault ceiling that evokes the barrel-roofed extension.

Horan says: "The one thing is, it still has the deep-set, cottage windows, but that works for yoga and meditation practice where there's an inward focus. It gives a kind of snug feeling." Sampson, one of Ireland's more prominent ecological-ly-minded architects, says that over time building to the passive house standard has become the norm for him.

"I've been practising fourteen or fifteen years now, and from the start I was doing eco-buildings. I very quickly got into passive housing. What started me was that I did a house with Duncan Stewart, and I remember it was timber frame with recycled insulation and a grass roof.

"Toward the end of the project Duncan said: 'Now that you've done this, you'll have to do passive house'. I was a bit knocked back, but I looked into it, and one thing led to another."

Sampson says that clients sometimes want to obtain passive house certification, but many just want the performance advantages of a passive house.

"We've a few certified but it tends to be that they want the performance rather than the certificate. The first one I had certified was in 2009 or 2010 and I'm currently putting three through certification."

This time, however, the constraints of a complex multi-part building, of different ages, meant passive house certification was not on the cards.

"The new extension would perform to passive standard, but if you're looking at the house as a whole, the previous extension would let it down."

Both Sampson and Horan remained interested in aesthetics throughout the design and build, so the environmental concerns, whether about energy use or embodied energy, could not be allowed to swamp everything.

"Passive houses prefer south-facing windows but at the same time, you've still got to produce architecture. You can't throw out architecture just because you're doing passive house," Sampson says.

Making the house part of the landscape was something that was always a part of the plan. "The site has amazing views of the Burren, but [previously] the only way to enjoy them was to be outside.

"In Ireland it's especially important to bring in lots of daylight and connection to the outdoors. There's no point in building a passive house and then having it so dark that you have to have the lights on all day."

As always, airtightness and thermal bridging were also crucial to the build. Sampson says the new extension was built to a passive house airtightness spec, but the building was tested a whole, and achieved an air permeability result of 3.39 $m^3/hr/m^2$.

The use of glue-laminated timber for some key structural elements helped to avoid the use of steel, which acts as a thermal bridge that can transfer heat out of a building, as well as having a big carbon ▶

Photography: Kelvin Gillmor

footprint.

"In this case, the guy who did the timber frame [Matthew O'Malley Timber Ltd] doesn't use any steel so there was no thermal bridging. The builder Niall from GreenTec is excellent too. He really understands what low energy building is all about," says Sampson.

The windows are aluminium-clad timber units from True Windows, with the aluminium providing essential protection on the rain-battered west coast of Ireland. Sampson also says that in order to reduce the build time, the team decided to order the windows from the project drawings, rather than on-site measurements.

"In this project that was a real challenge, because the link to the extension has two walls of glass windows with split levels floors and floor-to-ceiling windows." Sampson says it took tireless work and co-ordination between himself, the contractor, timber framer and window supplier to make sure it came off.

Meanwhile Ecocel cellulose — made in Cork from recycled newspapers — was used for insulation of walls and roof in the new extension, both as it is a natural material and also because it acts as a carbon sink in its own right.

"Primarily cellulose, recycled newspaper material, that's what we prefer to use," says Sampson. "The first thing is energy performance in building, but once you get that down the next thing to look at is the energy that goes into making the building.

"We always like to use materials that are renewable, essentially, and carbon sequestering. It's pretty much accepted that there's way too much carbon in the atmosphere, so every time you use material that contains it, you're taking it out of the air: timber and cellulose do that well.

"Cellulose starts as timber, which is turned into pulp, then paper, then it is recycled into insulation. Apart from being carbon sequestering it is also a recycled product."

The dwelling has three heat recovery ventilation systems, one for each of its main parts. The yoga studio had quite specific ventilation requirements: the system had to be large enough to provide fresh air for up to twelve people in a small space, while also being very quiet, with large fans running at low capacity.

The main heating system is a Thermia air-to-water heat pump. "They used to have an oil-fired boiler and we took that out. There is underfloor heating in the cottage and the new extension, not that it's needed, and in the existing extension, we connected up the existing radiators," explains Sampson.

The passive extension is equipped with temperature sensors, so the heating only comes on when needed — which his rarely — but there are no fancy controls in the old extension, simply the original thermostatic radiator valves.

Future plans include solar PV, but of a particular kind — Tesla's Solar Roof cells, which replace, and resemble, traditional roof slates.

"As it's an extension and not a new build, renewable energy wasn't a requirement, but the client is very interested in PV. We've wired the house for the Tesla roof slates, but they're not available yet in Europe," says Sampson.

In the end, Sampson might be satisfied with the project, but the clients are thrilled. Horan says that they now have a house that is beautiful, comfortable and offers stunning views in the new section — and a more cosy, traditional feel in the cottage.

And yet, Horan says that the project almost didn't happen, such were the family's worries about what would be possible. "We knew that it would be difficult to combine the two existing buildings with a new extension in a way that would look right." In the end, though, they got the house they wanted.

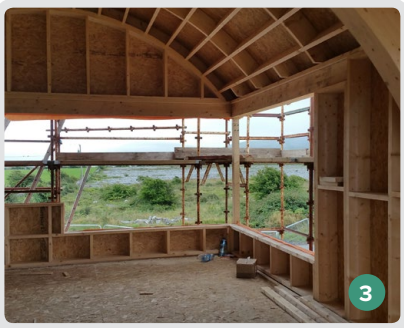
"There's a lot of houses around here with a barn, so it's part of the inspiration, [but] both ends of the barrels are fully glazed," he says. Most of all, it is, by design, a social space — both as a family home and as a business.

"The house really, really works. It's comfortable and the spaces, even though they are [in] different parts, it really works well, with everything close to the central staircase," Horan says.

"It's easy to move through and connect with people."

For more on Keith & Amanda Horan's meditation and yoga classes see **www.beingmindful.ie** and **www.kinvarayogastudio.ie**

CONSTRUCTION IN PROGRESS



1 The ground floor of the new extension features 250mm graphite enhanced EPS insulation under the 85mm GGBS concrete screed, and two courses of Quinn Lite thermal block at the base of the walls to minimise thermal bridging; **2** the use of glue-laminated timber for some structural elements, including the curved timber beams for the barrel roof, helped to avoid the use of steel; **3** the timber frame, by Matthew O'Malley Timber, features studs that were later insulated with cellulose insulation; **4** the True Windows timber alu-clad triple-glazed windows were ordered from drawings rather than on-site measurements to speed up the build, requiring exacting attention to detail; **5** Intello vapour control membrane fitted to the underside of the barrel roof, with service cavity to be installed underneath; **6** the final parts of the roof build-up, prior to installing the zinc roof cladding, are 20mm softwood treated boards, followed below by a ventilated cavity and Icopal breather membrane.

SELECTED PROJECT DETAILS

Clients: Keith & Amanda Horan
Architect: Miles Sampson
Contractor: GreenTec Building
Energy consultant:
Passive House Solutions
Structural engineer:
Charlotte Murphy Engineers
Mechanical contractor:
Western Energy Services
Airtightness tester: 2eva.ie
Timber frame:
Matthew O'Malley Timber
Airtightness products & sheep wool insulation: Ecological Building Systems
Windows & doors: True Windows
Cellulose insulation: Ecocel
Thermal blocks:
Quinn Building Products
Ventilation: Aerhaus
Heat pump: Ashgrove Renewables
Stove: Murphy Heating
Zinc roof cladding: GG Roofing
Green roof: Larne Lough Nurseries
Roof membrane: Renolit, via Laydex
Kitchen & fitted furniture:
Christian Vigurs Custom Furniture
Stone: Liscannor Stone
Wastewater treatment system:
Kingspan Klargester

IN DETAIL

Building type: 424 square metre home, office & yoga studio. New passive-level timber frame extension to existing house, renovation of existing cottage. Previous timber frame extension had minor reconfigurations.

Location: Doorus, Kinvara, Co. Galway

Completion date: August 2017

Budget: Undisclosed

Primary energy demand (DEAP): 60.63 kWh/m²/yr

Energy performance coefficient (EPC): 0.443

Carbon performance coefficient (CPC): 0.476

BER: A3 (60.63 kWh/m²/yr)

Airtightness (whole house): 3.39 m³/m²/hr at 50 Pa

Thermal bridging: New extension is of timber frame construction with full fill cellulose insulation between studs, sitting on two courses of Quinn Lite blocks. No steelwork.

Energy bills: Homeowners estimate an annual electricity bill for the first year in the house of €1,800, covering space heating, hot water and all electricity use for the home, office & yoga studio. Based on 21.43c/kWh and the running hours of the heat pump this includes circa €700/yr for space heating and circa €220 for domestic hot water, including immersion. Miles Sampson points out the space heating figure may be above average as the building was still drying out, the heating system required commissioning, and 2017/18 was a particularly cold winter.

Ground floor (new extension): Raft foundation insulated with 250mm graphite enhanced EPS insulation, 85mm GGBS concrete screed. U-value: 0.10 W/m²K

WALLS
New extension: Prefabricated timber frame with zinc or cement board cladding externally followed inside by ventilation cavity, 11mm OSB, 219mm cellulose filled timber studs, Intello vapour variable barrier/airtightness membrane, 50mm mineral wool filled service cavity, plasterboard. U-value: 0.19 W/m²K
Cottage renovation: Existing rough stone wall, followed inside by existing foam filled drylining, 50mm sheep wool insulation fill between battens, Intello vapour variable barrier/airtightness membrane, 50mm sheep wool insulation filled service cavity, plasterboard. U-Value: 0.2 W/m²K

ROOF
New extension: VMZinc externally, followed inside by 20mm softwood treated boards, ventilated cavity, breather membrane, 11mm OSB, 319mm cellulose insulation between rafters, Intello vapour variable barrier/airtightness membrane, 50mm mineral wool filled service cavity, plasterboard. U-Value: 0.15 W/m²K
Extension link: Planted sedum mat and drainage tray, followed underneath by Renolit Alkorplan single ply roof membrane, 100mm PIR insulation, 18mm OSB, rafters, Intello vapour variable barrier/airtightness membrane, 22mm service cavity, plasterboard. U-Value: 0.16 W/m²K

Renovated cottage: Existing natural slates, followed underneath by existing insulated rafters, existing plasterboard, 200mm sheep wool insulation on new suspended ceiling, Intello vapour variable barrier/airtightness membrane, plasterboard. U-Value: 0.2 W/m²K

Windows (extension): True Windows triple glazed aluclad timber windows with argon fill, low-e coating and warm edge spacer bars. Ug-value: 0.55 W/m²K, average U-Value: 1.00 W/m²K

Heating system: Ashgrove Thermia iTec 16 air-to-water heat pump with COP of 4.21 distributing to underfloor heating throughout extension and renovated cottages and radiators in existing house. 79% efficient, Nordic Swan-certified Scan 68 wall-hung wood burning stove.

VENTILATION
New extension: Vents VUT 350 heat recovery ventilation system 85% efficiency.
Old extension: Vents VUT 550 heat recovery ventilation system 81% efficiency.
Renovated cottage (yoga space): Vents VUT 700 heat recovery ventilation system 81% efficiency oversized in order to minimise noise in the yoga space.

Electricity: Wired to add PV solar slates to existing cottage roof when Tesla Solar Roof panels become available. Wired to add electrical car charging point.

Green materials: Timber frame, glulam structural elements including curved glulam beam, Irish grown sedum mat for roof, cellulose recycled newspaper insulation, sheep wool insulation, GGBS cement.

Photo: John Gomez

ICONIC

LONDON SCHEME PIONEERS VENTILATION-LED RETROFIT

Hundreds of flats at the Thamesmead estate in South East London were suffering from horrendous damp and mould. But an ambitious new project has aimed to fix these problems at their root, while demonstrating a fresh approach to making old social housing healthier and more comfortable for occupants.

Words by Kate de Selincourt

Fuel poverty is always miserable. But condensation, damp, and mould are among its most demoralising consequences. Mould is particularly horrible – and humiliating – to look at, and rightly makes its victims fear for theirs and their children's health. Mould not only harms respiratory health, and may exacerbate allergic conditions like eczema, it also increases people's risk of mental health disorders such as depression.[1]

Energy efficient building fabric has never been British construction's strong point – and without abundant, affordable heating, homes of any era can be hard to keep warm and dry. But the damp and mould that had taken hold in some of the concrete housing on the extensive 1970s Thamesmead development east of London shocked even seasoned professionals.

The striking brutalist architecture of the 2,500 flats and maisonettes around Southmere Lake has brought the development fame as a film and advertisement set. Still visited on architectural tours, the homes feature the angular profiles, broken massing, elevated walkways and cantilevered balconies characteristic of the style. But the distinctive construction incorporates an epic array of structural and geometric thermal bridges.

Originally the homes were served by an unmetered district heating system — if anything, the dwellings were too warm. They were however generally dry. But when the giant boilers reached the end of their working life 20-odd years ago, replacing the system was too expensive, so instead the previous landlord installed individual gas boilers. But as fuel prices rose, many households fell into fuel poverty.

And with fuel poverty came condensation, damp and mould. Stock condition surveys suggested that by the time Peabody housing association took over the estate four years ago, almost one-fifth of the flats were affected.

Some of the mould was "truly horrendous", says Simon Jones of ventilation manufacturer Aereco, who has been working with Peabody and others on an ambitious new project to rehabilitate affected flats. "Some of the rooms just looked as if they had been painted black. Even the skylights were black," he says.

Energy consultant Peter Rickaby, who was brought in by Peabody to advise on how to tackle the problems, says the mould was he the worst he has seen in 35 years. "It was just appalling. Quite a lot of households comprise single parents with small children, and the mums were scrubbing off the mould with bleach, then trying to keep their kids away from the bleach."

When the properties were taken over by Peabody, little had been done to improve them for a long time. However, the worst-affected dwellings had been mould-washed and redecorated, some of them time and again. In just one year 3,000 damp and mould-related "repairs" were logged, affecting 1,900 homes, with mould wash and redecoration costing £1,275 a time. Peabody wanted to sort out the problems at source.

Large-scale regeneration is coming to Thamesmead, thanks to the imminent arrival of Crossrail (the Elizabeth Line). But the regeneration will be spread over years if not decades, so there are some homes – including some of those worst affected by mould and damp — which will not be not be replaced or improved for ten years or more. And as Peter Rickaby says, "you can't leave people like this for ten years."

Peabody's objectives were to intervene more immediately to manage the condensation and mould — eliminating it where possible — and at the same time, mitigate fuel poverty.

In order to work out what to do, Peter Rickaby and Peabody first had to assess the stock. They developed a scoring system to work out which dwellings were most at risk of condensation, damp and mould (CDM), based on each dwelling's SAP score (the energy efficiency rating part of the energy performance certificate, or EPC), household income, number of occupants and previous reports of either CDM or excess cold.

By visiting some properties and fine-tuning the scoring system, they found it could identify 95% of the properties suffering damp and mould. "Just about every home scoring as 'high risk' was really bad, many were not lettable," says Rickaby.

The next step was to design the interventions. The usual way of tackling fuel poverty is to increase affordable warmth – by improving heating systems, upgrading windows and doors, and insulating the fabric. But the heating systems at Thamesmead were already fairly modern, and most of the windows were already double-glazed.

In order to improve the fabric performance, the solid walls would have to be externally insulated. But the complicated geometry — with pointed gables, balconies, walkways and piers — would have made this incredibly difficult. So, if they couldn't insulate, what could be done?

We are just beginning to understand that insulating buildings without ventilating at the same time is potentially risky. But how about ventilating without insulating, could that work? While it wouldn't help to make people living in fuel poverty any warmer, or save them money, might it still help them if their homes were easier to keep dry?

> Some of the rooms just looked as if they had been painted black.

Peter Rickaby thought it might. "Occupancy was one of the most powerful predictors of damp and mould. Higher occupancy implies higher moisture production, suggesting ventilation would be a worthwhile intervention," he says.

But with occupants in fuel poverty, wasn't there a risk of exacerbating the situation by introducing cold air? "This was one reason why energy advice was going to be critical to the whole programme."

A three-tier programme was devised, depending on risk scores (see 'Thamesmead condensation, damp & mould strategy'). At its heart was energy and moisture management advice, which was given to everyone. For those at medium risk there was the offer of smart thermostats, and a small number of boiler repairs, and for the high-risk dwellings, all this plus mould washes and the installation of mechanical ventilation.

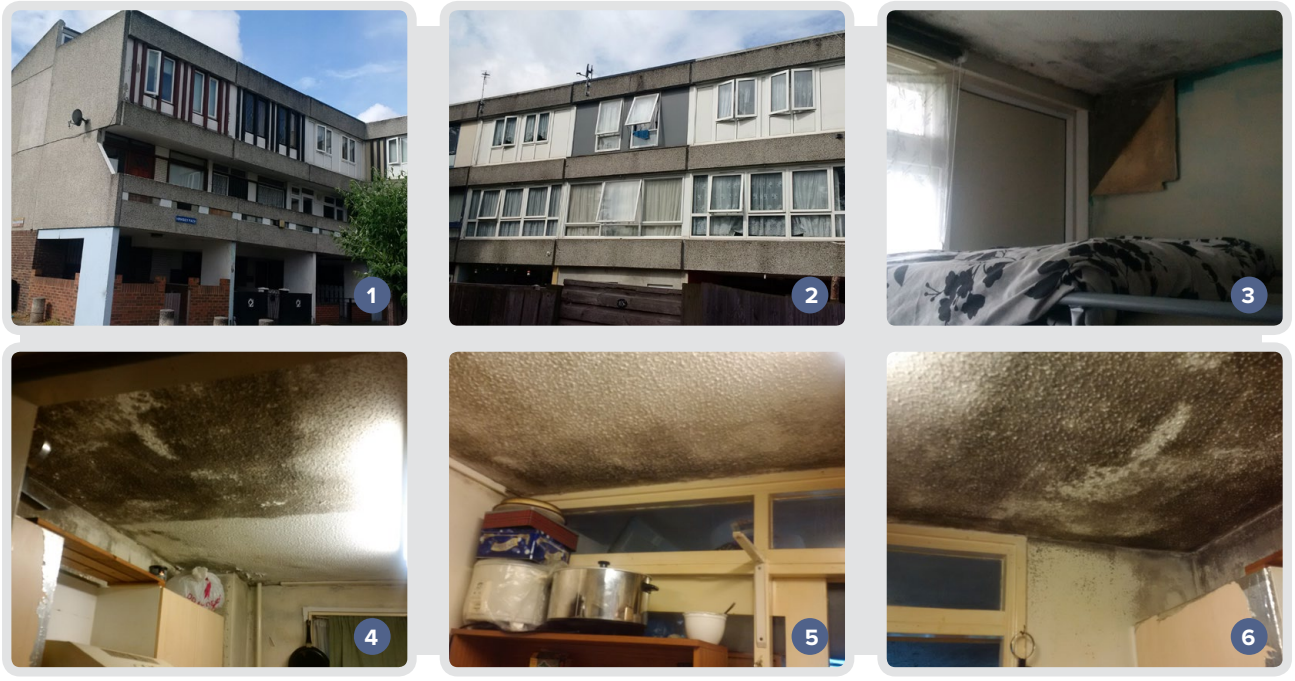
Ventilating right

As Peter Rickaby explains, the so-called 'system one' ventilation in many of our homes — trickle vents and intermittent ventilation – can't deal with CDM issues like those at Thamesmead. "A lot of the mouldy homes had intermittent extract ventilation, but it was not doing its job, for the usual three reasons." Namely, either it was inadequate, left unused because it was too noisy, or occupants were anxious about the energy costs, or it was broken.

Rickaby and the team at Peabody were clear that continuous mechanical ventilation would be needed, in order to move enough air through the flats. Mechanical ventilation with heat recovery (MVHR) was one option, but despite its potential for comfortable and effective performance, it just wouldn't have been practical to install. The solid concrete construction, and the presence of asbestos in some partitions, meant that running both supply and extract ducts throughout the flats would have been far too difficult.

The team ended up plumping for continuous mechanical extract ventilation (MEV). But it would have to work. Research by ventilation expert Ian Mawditt and others has shown that many MEV installations fail to perform as they should, for the usual reasons – the fans are often underpowered, inlets are mis-installed, and systems get disabled by occupants, often because of noise.

Peter Rickaby helped Peabody draw up a specification (see 'Ventilation specification at Thamesmead), and it was a challenging one. The ventilation had to be effective – effective enough to remove moist air at one-and-a-half times the rate required by the building regulations, in order to deal with the highest flat occupancies. However, it should not over-ventilate the homes, as this would penalise occupants already in fuel poverty by wasting heat — so it needed to ramp down when not needed, or when occupancy was low.



1 & **2** Some of the flats at Thamesmead that were treated as part of the scheme; **3** - **6** Energy consultant Peter Rickaby says some of the flats were affected by the worst mould he had seen in 35 years, while Simon Jones of ventilation supplier Aereco said that, "some of the rooms just looked as if they had been painted black."

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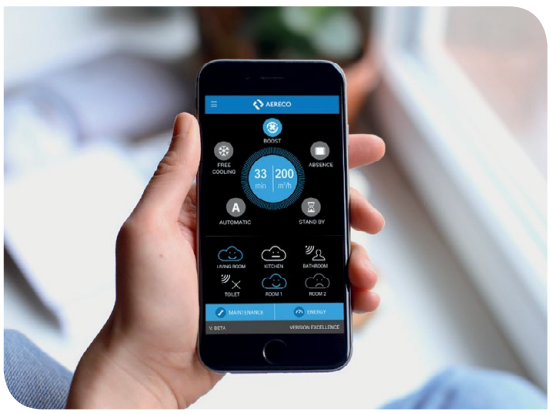

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AERECO

(above) Mould-free flats after the installation of new Aereco ventilation systems, which are seen here before and after boxing off and painting. "Most residents love the Aereco system as they don't have to interact with it, it does the work by itself," says energy advisor Nadira Moreea. There has been no recurrence of damp or mould reported to date.

It also had to be quiet. Ventilation can be as powerful as you like, but it is no use whatsoever if is turned off by occupants because it is too noisy.

Buying air quality

A system that didn't deliver the specified air changes in practice would not sort out the CDM problems faced on the estate – and would effectively be a waste of everyone's time and money. So, Peter Rickaby and the team at Peabody made a bold move. They turned the process for procuring the ventilation systems around, and based it not on paper compliance, but on real-world performance.

As Rickaby explains: "We told our potential suppliers, 'we are not buying a ventilation system from you, we are buying air quality. You have to guarantee that you are delivering this to us. We then required suppliers who were bidding for the contract to offer a live demonstration that their system would meet the specification." And crucially, the contract would make them responsible for that performance of the ventilation systems when installed.

The winning supplier would take ultimate responsibility for the system performance and had to make a commitment not just to sell fans, but to design the full systems, train and oversee the contractors, and guarantee the performance.

> No residents have experienced a recurrence of condensation, damp or mould.

Initial interest from half a dozen or so suppliers was whittled down, and the contract went to Aereco, who were the only bidder to meet all the criteria. The Aereco system that was chosen ducts moist air to a centralised extract fan, and then out of the dwellings, with fresh air entering though moisture-sensitive inlets in living spaces and bedrooms. These inlets automatically adjust the flow rate of fresh air based on humidity in the flats. No fully decentralised systems were available that met the specification in terms of energy use, responsiveness and noise.

Aereco's Simon Jones recalls that the contractors were uncomfortable at first with the arrangement. "Contractors aren't used to having their work signed off by the supplier before they are paid — it was very different from the usual arrangements." But as he explains, once they had worked with this approach, they bought in fully and rose to the challenge.

Jones says: "The spec required a proper team effort, and full buy in from all the supply chain. We worked very hard with the contractor, particularly on the acoustics, and they really got a hold of this. It can take nine months to get contractors familiar with the requirements, but NJS [the ventilation installer] and Vinci [the main contractor] got it very quickly, including devising their own pre-compliance checks before we came to test the installations."

Installation was not straightforward. Because of the solid concrete construction, drilling to run extract ducts though partitions, floors and ceilings was incredibly noisy and reverberated right though the block. Sometimes it was just too difficult, and routes were complicated by asbestos panels that had to remain undisturbed, so in some homes it ended up being cheaper and simpler to install two extract fans rather than one. Plywood boxes were built to contain the fans and ducts, all painted to match the décor of the flats.

Installing the supply vents was a lot easier: they were simply cut into the uPVC window frames. "Our demand-sensitive inlet vents look like normal vents really, just a bit bigger," Simon Jones says. "You can 'close' them but there is always a minimum flow rate."

'Considerable success'

The first installations took place last winter, and to date 272 flats have been treated, with 264 of these getting new ventilation systems. It is becoming clear that the programme has had considerable success in achieving its objectives. Energy advisor Nadira Moreea of Peabody, who has been following up with the households, says "generally, everyone has been extremely happy with the works done," and no residents have experienced a recurrence of condensation, damp or mould.

"Most residents love the Aereco system as they don't have to interact with it, it does the work by itself, and most residents have left the inlets on windows open fully to allow maximum ventilation," she says. "Some mentioned that the boxing [for the ducts and fans] was quite large but all agreed that the system had reduced the amount of moisture in their home, as they noticed after cooking and bathing."

While people aren't generally saying that their homes feel warmer, "the majority say that their home feels more comfortable," Moreea says. "On the energy advice visits I would talk about optimum heating controls, and draughtproofing, which could help with keeping the home warm – though some flats were already extremely warm."

The team are still early in the process of collecting data on residents' energy use. Some residents have already reported noticeable bill savings, however.

The hope is that costs will have fallen for many. Three-quarters of the residents were initially on expensive pre-payment meters, and many were helped to switch. As Peter ▶

Rickaby recalls: "Nadira is absolutely brilliant. I went out with her on some home visits and saw how she was able to get people switched to a new tariff — then and there."

Some occupants also say they have turned down their thermostats, reducing wasteful heating 'overshoots'. And no-one has asked for their ventilation system to be turned off, or disabled it themselves – again, suggesting that people are comfortable.

'Dramatically improved indoor air'

With the help of the Switchee smart thermostats installed in some of the newly ventilated households, it has been possible to get a sense of how internal conditions have changed. While the timing of the programme prevented the collection of much "pre" data, it is clear moisture levels fell after the ventilation systems were installed (see Graph 1, p73).

There has been significant behaviour change too, with three-quarters of occupants now reporting that they shut the bathroom doors, and dry their laundry outside when they can.

"We have seen dramatically improved indoor air quality, particularly with regard to humidity," Peter Rickaby told the conference of the Association for Environment Conscious Building in September. "Although we are not monitoring other pollutants, it is noticeable that the homes smell fresher, too."

Anecdotally, some occupants believe they have better health. One resident told Passive House Plus that her asthma was not so bad now her flat had ventilation, while another told the energy advisor that in the past, her children would wake up in the night, and cough a lot, but since the works were completed they no longer cough.

(above) Some Peabody residents have reported energy savings, such as Mr Robinson, who claims he's seen his heating costs fall by 30%.

Perhaps the most distinctive feature of this project was the approach to the procurement of the ventilation. The professionals who worked with Peabody praised the association for grasping the need to for this radical approach. As Simon Jones put it: "Peabody were willing to set a robust spec, and had the courage to enforce it."

The result, says Peter Rickaby, is that "we have 100% compliance with not only Part F [of the building regulations, which deals with ventilation], but also our own, higher standards – which is very unusual, probably unique. And no-one has switched it off – again, really unusual."

"It is rare for ventilation to be both unobtrusive and effective. Industry thinks they already have effective systems, but they get switched off, or they are 'acoustically commissioned' so the flow is too low. Either way they are not effective. It's my challenge to industry — give us effective but quiet ventilation, quiet enough that it will be left on."

He's also very happy that despite not being able to insulate people's homes, their living conditions have got so much better.

The usual approach to retrofit tends to be to upgrade the building fabric first, then do the heating and ventilation. But condensation damp and mould issues may be urgent, he points out. "If you are on a long-term stock programme and won't get to affected properties for years or decades, we have shown there is benefit from intervening in the shorter term with a focus on ventilation."

"I was surprised in a way – I have always said that for households in fuel poverty, heating, ventilation and insulation all need doing, so my first concern was 'is this going to work with no insulation?'"

"We have increased the heat a bit, and added very effective ventilation. I think the occupants are still in fuel poverty, but we did get rid of the damp and mould. What I have learned from Thamesmead is that if you can put in good ventilation, so long as you can reduce fuel costs a bit, it goes a long way to tackling CDM problems. So, I'd say – don't be deterred if you can't manage insulation right away. You may still be able to make things better."

[1] The World Health Organization (WHO) found that extensive exposure to dampness and mould increased the chance of depression by 60 percent. (Cited by South-East Public Health Observatory, 2006 & Nottingham City Homes, 2016; Also, Harris J, Hall J, Meltzer H, Jenkins R, Oreszczyn, T & McManus S, 2010. Health, mental health and housing conditions in England. National Centre for Social Research: London)

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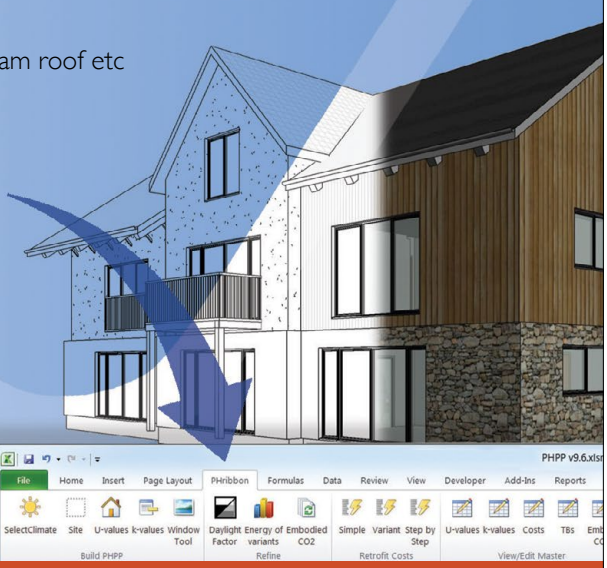

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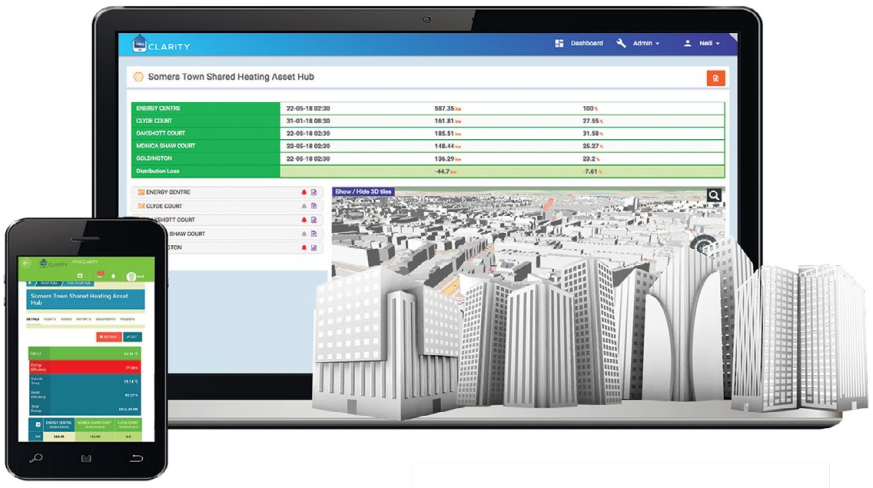

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Vapour pressure differential: a better way to measure moisture?

Vapour pressure differential is a neat 'at a glance' way to assess the effectiveness of a ventilation system — especially in a building where damp is a concern. The plot in Graph 2 shows the vapour pressure differential in the same dwelling as that of the relative humidity graph (Graph 1) whose ventilation was installed in February 2017.

Vapour pressure, or absolute humidity, is the total amount of moisture held in the air. By contrast, relative humidity — the most common way humidity is measured — is a percentage of the maximum amount of moisture the air can hold at its current temperature. Vapour pressure will go up or down directly in response to moisture being added or removed from the space, independently of temperature.

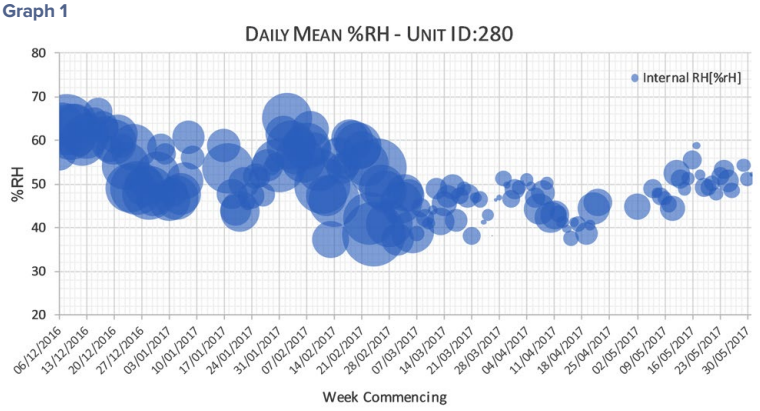
The relative humidity of outdoor air varies, but as long as it is cooler outside than inside, you can be pretty confident that the absolute humidity of outdoor air will be lower – which is what makes it possible to keep a dwelling dry by ventilating it.

Graph 2 below, prepared for the Aereco team by ventilation researcher Ian Mawditt, displays the difference between the absolute humidity in the outside air and that indoors. Moisture-generating activity adds moisture to the air, driving absolute humidity up, but with an effective ventilation system that moist air is displaced by a stream of drier outdoor air, so the difference between outside and inside cannot climb too high.

The orange blobs, relating to the time after the ventilation was switched on, show how the absolute humidity of indoor air, as compared to outdoor air, was reduced. The installed ventilation was more effective in replacing moist indoor air with fresh outdoor air than the previous system (or, possibly, lack of system) – shown in blue blobs — had been.

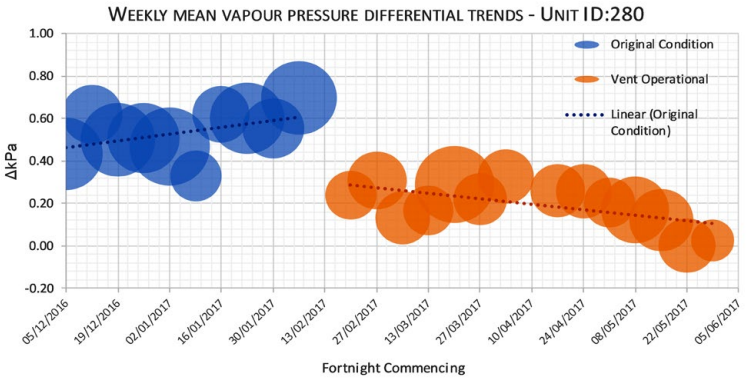
Plots of vapour pressure differential cut through the day-to-day ups and downs of relative humidity. Indoor relative humidity ranges up and down depending on the humidity of the outdoor air, indoor moisture production, and indoor temperature, while the vapour pressure differential varies with just one factor: how much of the moisture being added inside the dwelling is removed? And it is that factor that tells us if the ventilation is doing its job or not.

Graph 1



(Graph 1) A plot showing relative humidity in one dwelling before and after the installation of a ventilation system (in February). Humidity became more stable, with higher readings eliminated, suggesting that the ventilation was effective in controlling the moisture levels, as intended.

Graph 2



Thamesmead condensation, damp & mould strategy

Lower-risk households:

- Energy and heating advice, and help with tariff switching – at the start of the project 75% were on prepayment
- Moisture management advice re clothes drying, closing doors to wet areas, putting lids on pans etc
- 176 energy advice visits to date

Medium-risk households:

Advice as above, plus:

- Smart thermostats installed in 163 households. According to the suppliers, Switchee: "By adjusting to occupancy patterns and local weather, the Switchee smart thermostat can reduce the amount of time the home is heated, thus saving energy, cutting CO_2 emissions and reducing household bills". The thermostat also feeds back information on indoor temperature and humidity to the landlord, flagging up households who may be falling into fuel poverty or at risk of condensation, damp and mould. Because of this data sharing element, some households declined the thermostats
- Boiler replacement where the boiler was inefficient or faulty
- A small number of dwellings had unfilled cavity walls, which were insulated

High risk households:

Advice and interventions as above, plus:

- Three-part anti-mould paint. Treated areas also received one coat of white emulsion and residents received a £40 DIY voucher per room treated. (261 households so far)
- Installation of continuous, demand controlled, whole-house mechanical extract ventilation (264 households to date)

Ventilation specification at Thamesmead

- Capable of delivering up to 150% of minimum ventilation rate in Part F (Approved Document F) of the building regulations
- To provide capability to deal with higher occupancy than Part F (Part F only assumes double occupancy in one bedroom)
- Demand-controlled
- Adjust ventilation rate accordingly between 35% and 65% relative humidity (and go at top speed above that)
- Ramps down when moisture levels are low, to reduce heat loss
- Quiet: 30 dBA at one metre's distance

All doors were also to have 10mm undercuts to ensure air flowed through the whole dwelling

Marketplace News

NBT set for 50% growth in sales this year

Pavatex wood fibre insulation being installed.

Woodfibre insulation specialist, NBT, is on target for a 50 per cent growth in sales volumes for 2018, indicating that specifiers are increasingly selecting woodfibre for its thermal performance, year-round comfort and moisture dispersion properties.

Woodfibre insulation currently accounts for less than one per cent of the UK insulation market but according to NBT supply problems in the mineral wool segment of the insulation market, coupled with fire risk concerns for poly-iso insulation products, have encouraged specifiers to re-examine how they are insulating buildings.

The company's Andrew Mitchell said: "Woodfibre insulation, like the Pavatex range that we supply, is often the system of choice for timber and CLT projects, and well as the environmentally-focused projects for which you'd expect it to be the solution of choice due to the low embodied carbon thermal performance benefits.

"Pavadry woodfibre insulation, developed as part of the Pavatex range specifically for refurbishment projects, has also proved a popular choice for raising the thermal performance of 'solid wall' structures without compromising their building physics or external appearance.

"Current market conditions affecting other types of insulation are now prompting specifiers to look more closely at the benefits woodfibre can offer in terms of performance, ease of installation, technical support and cost, which is taking woodfibre beyond the realms of 'eco' and 'heritage' to meet the needs of any project."

The increased sales volumes NBT has achieved over the course of this year, combined with exponential growth in enquiries for forthcoming schemes, reflect a varied project portfolio across the residential, office, culture and hospitality sectors, including both new builds and refurbishments.

Mitchell added: "The natural properties of woodfibre mean that it combines reduced heat loss with improved building comfort and low combustibility for a temperate year-round environment and low risk installation.

"It's a sustainable choice made from renewable materials that delivers carbon lock up of ten tonnes for the average new build dwelling, but current market conditions are prompting specifiers to focus on woodfibre's buildability and performance credentials too." ■

VRM Tech aim to digitise passive house building

VRM Tech, the developer of innovative mobile software apps for the construction industry, has launched Virtual Construction Management Platform (VCMP), a cloud-based app that aims to radically streamline the management of construction projects.

VCMP was developed as part of Built2Spec, an EU-funded project that sought to develop digital tools for better quality control of energy efficiency works on site, while integrating with the Passive House Institute's certification platform. VCMP has a particular focus on energy efficiency and the building envelope, and is particularly targeted at large passive and nearly zero energy building (nZEB) projects.

"All aspects of a project's design and specification are fed into the platform at the start and can be easily communicated to everyone on site, with tasks assigned to particular individuals, and then quality checked by project managers upon completion," said Neill Ryan of VRM Tech.

"VCMP allows for a consistent approach to quality control, to get things right the first time, rather than snagging at the end. Compliance with buildings regs and all necessary documentation come pre-built in the system."

"Individuals on a project are also assigned specific skills, and must have the required skills to tick off an action. Once a task is completed, it's then fed into an approval cycle so those managing the project can approve it."

VCMP users can also specify products to be installed, and as these arrive to site, someone is assigned the task of entering product barcodes into VCMP to make sure no incorrect substitution occurs.

The software was used on Durkan Residential's Silken Park passive housing scheme in Citywest, Dublin, which averaged airtightness results of around 0.2 ACH.

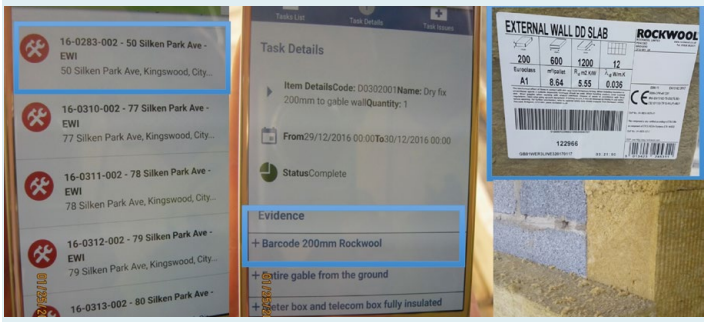
"Information and photographs from site are constantly being sent back to VCMP so project managers, designers, and architects can control quality."

Ryan also said that VCMP can be fully integrated with BIM. "It can take all of the information from the BIM model and allocate tasks — you can click on a wall in a room, for example, and see what tasks need to be done, and in what order, and those tasks can be assigned to specific individuals who tick them off as they go."

Ryan said the software should also make life easier for sub-contractors by digitally organising all the documentation they need on site.

"Documents can be tracked fully all the way back to where they originated, providing a full audit trail."

For more information see **www.built2spec-project.eu**. ■



(above) Screenshots demonstrating how VCMP allows users to ensure the specified product, in this case Rockwool external insulation, is used on site.

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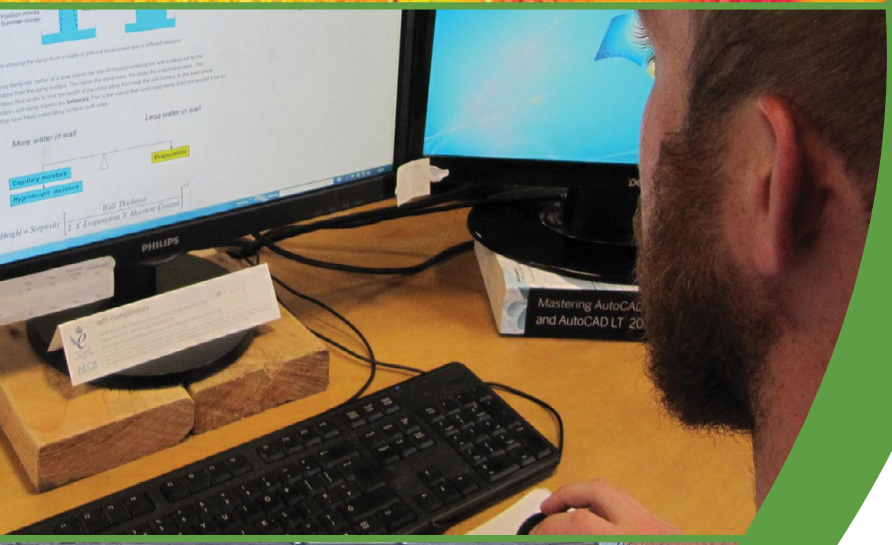

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Understanding enthalpy heat exchanges for MVHR

Enthalpy heat exchangers are particularly useful in cold, dry alpine environments.

Leading ventilation supplier CVC Direct has advised anyone specifying an MVHR (mechanical ventilation with heat recovery) system to understand the basics of relative humidity and consider their own local climate before choosing a system with an enthalpy heat exchanger.

"Our Brink Flair 325 MVHR unit comes with an optional enthalpy heat exchanger, and at CVC Direct we often get asked whether an enthalpy heat exchanger is needed," says Nicholas Vaisey of CVC Direct.

"We also often get asked whether the air in a passive house is dry as a result of the ventilation. The answer is yes, the air is drier in a passive house with MVHR, in comparison to one with poor ventilation. This however is generally regarded as a good thing – excess moisture can lead to the growth of mould, and provides a good environment for bacteria, cockroaches and dust mites. It can also harm the health of the occupants and cause damage to the structure of the building and furniture."

Vaisey points out that on the other hand, if the relative humidity internally is too low, it can lead to dry skin, itchy eyes, and a dry nose and throat, creating a very uncomfortable environment for the occupants. It is suggested that the ideal level of relative humidity in a home is between 40% and 60%.

The major sources of moisture inside the home are the occupants, cooking, showering and plants. When an MVHR system without an enthalpy heat exchanger is used, that moisture is lost to the outside — all that is transferred to the incoming air is heat. These systems also remove moisture from incoming air.

However, the Flair 325 comes with an optional enthalpy heat exchanger. This works by allowing water vapour from the extracted internal air to transfer to the incoming air, raising the relative humidity. The quantity of moisture that is transferred depends on the relative humidity of the indoor and outdoor air and may run to about 60%. This is particularly useful with cold, dry alpine environments, with low levels of relative humidity. The enthalpy heat exchanger also recovers both thermal and latent energy from the extracted internal air, energy which would ordinarily have been lost to the atmosphere.

"The average relative humidity in the UK is between lows of 70% and highs of 90% which is considered high, suggesting humidity recovery is not that big an issue in the UK," Vaisey says. ■

Passive house professionals flock to Ecological airtightness tour

Professionals from across the passive house and building physics communities gathered in London and Swindon during October thanks to an airtightness events programme hosted by Ecological Building Systems, in partnership with the BBA and pro clima.

Originally conceived to celebrate BBA accreditation of pro clima Intello Plus intelligent airtight membrane, the events developed into a programme of five full-day seminars, each worth six structured CPD points, which toured the UK throughout October.

Combining presentations from Ecological Building Systems and pro clima experts with guest speakers, installation demonstrations and chaired discussions, the events focused on specification strategies for optimising energy efficiency via the building fabric, safeguarding buildings from moisture-related structural damage, and creating healthier indoor environments.

The Swindon event at the National Self Build & Renovation Centre featured a keynote address from sustainable design expert and TV presenter, Charlie Luxton, who talked the delegates through his design and construction journey for his own low energy home.

One attendee, Chris Dewhirst of Evolved Design, commented: "The Perfect Airtight Seal Tour event in Swindon was so worthwhile from beginning to end with a high calibre of presenters, practical demonstrations and opportunity to network with fellow delegates so that I came away full of information and enthusiasm. There was no hard sell, just really valuable knowledge sharing and it was well worth a day out of the office."

Meanwhile, the London event at The Building Centre on 18 October was introduced by Simon Corbey, associate director at the Alliance for Sustainable Building Products (ASBP), and featured a keynote presentation from passive house consultant Patrick Chester and Ioan Sulea, director of eco-building company Oasis Construction. The tour then moved on to Belfast, Glasgow and Birmingham.

UK general manager of Ecological Building Systems, Penny Randell, commented: "We are delighted by the response to this seminar programme and the number of professionals that have taken time out of their busy schedules. The growth in environmentally sound specification and construction relies on knowledge sharing and cooperation between experts in the field and that's what we've facilitated with these event programmes." ■

(above) The Ecological Building Systems team line up with Charlie Luxton (third from right) prior to the Perfect Airtight Seal event in Swindon.

Foam glass a sustainable aggregate alternative — Mike Wye & Associates

Foam glass gravel provides a sustainable alternative to traditional aggregates and hardcores, according to Mike Wye & Associates, the leading supplier of traditional and sustainable building materials.

Foam glass gravel (or aggregate) has been used widely across mainland Europe for a couple of decades but is a relatively new construction material to the UK market.

"It is a lightweight material made from 100% recycled glass," explained Carl Sanger, Geocell sales executive at Mike Wye & Associates.

"Ninety per cent of glass used in the production of foam glass comes from bottles and other coloured glass. The other 10% is clean, sheet glass, mainly from windows."

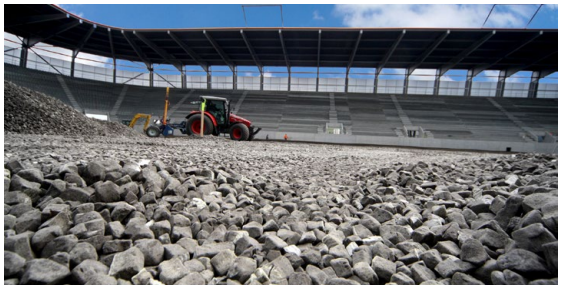
"Geocell foam glass is exceptionally stable, durable, safe to handle and more importantly an environmentally-friendly building material." Sanger outlined some of the key characteristics of the material:

- **Insulation:** no extra frost protection is necessary, and the complete omission of other floor sub-components is possible in thermal bridge-free construction (design value 0.08 W/mK).
- **Load-bearing:** the cellular structure and extremely high specific surface of foam glass facilitate an exceptional pressure load (compressive strength design value of 275 kN/m^2).
- **Stabilising:** the improvement of the load-bearing capacity of unstable terrain can replace measures such as pillar foundations and consolidation fills.
- **Free draining and non-capillary:** the closed-cell surface of foam glass prevents soil moisture from entering the structure.
- **Inert:** it meets the highest standards for inert building materials. Leaching tests did not show any resulting adverse environmental effects whatsoever.
- **Lightweight:** the bulk weight of GEOCELL foam glass is only 150 kg/m^3. Standard hardcore weighs approximately 20 times more.
- **Fire resistant:** non-combustible Class A1 with a melting point above 700C.

"These beneficial properties explain why foam glass is being used increasingly in the UK for the renovation of historic buildings, in new build projects, and across various civil engineering applications," he said.

"Geocell foam glass is extremely light and allows for dry and extremely simple installation." The system is already registered with Local Authority Building Control (LABC).

Sanger added: "The UK glass industry has the ability to recycle millions of tonnes of glass each year. Glass can also be recycled indefinitely without compromising quality. Using virgin materials in construction can only be sustained for a limited period and construction companies now need to show compliance in reducing CO2 emissions for all new buildings." ■



(above) Geocell being laid under the AFG Arena in Switzerland.

Viessmann launch new ultra-quiet air source heat pumps

(above) The Vitocal 222-A, one of two new air source heat pump models introduced by Viessmann.

Viessmann has introduced two new air source heat pumps, the Vitocal 200-A and Vitocal 222-A, which boast innovative noise-reduction technology. Both operate so quietly that they are suitable for densely built-up areas such as terraced housing estates, and both deliver high energy efficiency with low operating costs, according to Viessmann.

With outputs of 2.3 to 11.8 kW, and with a reversible circuit within a single unit to enable switching between heating and cooling, the Vitocal 200-A and 222-A are identical except that the 222-A has an integrated 220 litre domestic hot water cylinder.

Both heat pumps feature Viessmann's new "advanced acoustic design". The company said this combines a sound-optimised fan, designed to harmonise the acoustic frequency range, with intelligent speed control to reduce airborne noise. "This effectively stifles the lower frequency sound of conventional heat pumps which can be perceived as disturbing, according to Viessmann, and the result is that the pumps are barely audible," said the company. Noise pressure in night mode at a distance of three metres is 35 dB(A).

The Vitocal 200-A and 222-A are of compact monobloc design, with separate indoor and outdoor units connected by water pipes. The outdoor unit contains one or two fans, depending on power output. Maximum flow temperature is up to 60C when the temperature outdoors is as low as -10C.

The energy rating of both new Vitocal heat pumps is A++. The COP (coefficient of performance), according to the EN 14511 standard, is up to 5.0 (A7/W35) and up to 4.1 (A2/W35).

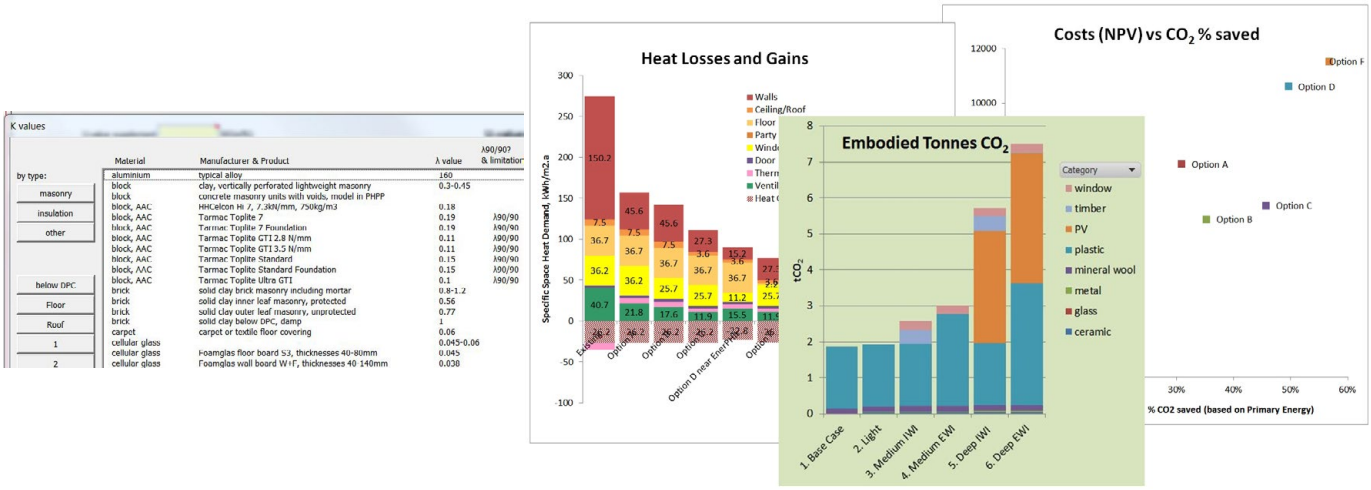
No minimum distance is required between the indoor and outdoor units, no refrigeration leak test is required because the cooling circuit is hermetically sealed, and no F-gas certificate is needed because the connecting pipes to the outdoor unit are filled with water.

These new heat pumps are also simple to operate, via the easy-to-read Vitotronic 200 control unit, Vitoconnect web interface and free ViCare smartphone app.

Hugh Jones, Viessmann product manager, commented: "No one wants to look at an ugly heating appliance or hear it whirring away when they are sitting in their garden – or hear noise coming from a neighbouring garden. By addressing these issues inventively, we have produced two new heat pumps which are pleasing to the eye and so quiet that they can be installed right next to a neighbour's property without causing problems." ■

Daylight, embodied carbon & more: advances in the AECB PHribbon software

Tim Martel of Optimal Retrofit describes recent advances in PHribbon, an Excel tool designed to improve the functionality of the passive house design software PHPP.



The AECB PHribbon — a set of tools for PHPP users — has grown, and some of the existing tools have been improved since September.

PHribbon is designed to greatly speed up PHPP (the Passive House Planning Package) and add extra functions. Half the tools are for data entry (new build or retrofit) but now it also includes a daylight factor calculation, written by Mark Siddall of LEAP, and embodied CO2 calculations. It's designed to make things easier and simpler, though it also has features for the most advanced users, and many of the buttons are designed to also work with Variants too – a tool developed by the Passive House Institute to enable designers to simultaneously model multiple design options.

There is a dialogue for entering λ-values (also known as k-value or thermal conductivity) which are the building blocks of U-value calculations. To help get to the one you want quickly these have been grouped into category buttons. Pressing on one of these buttons shows just the items in that category. Three are by material type — 'masonry', 'insulation', and 'other'. Another three are for special situations — 'below DPC', 'Floor' and 'Roof'. Users can go directly to the BBA certificate to obtain $\lambda^{90}/_{90}$ values, if the product has one, or else a record of where the figure was from. BBA certificates are generally available for insulation materials and certifiers usually require them for certification. Users may like to have their own lists of λ-values because architects do have preferred and familiar construction methods, and the way people think and categorise things can vary. Therefore, a huge amount of flexibility is built in. There are three completely empty category lists for users to name and fill as their own. The name they give appears on the button in the dialogue, replacing the one, two or three currently there. If that's not enough they can also redefine three of the other buttons. Items can be in more than one category and the category can be changed. Users can add any number of their own materials.

Many architects tend to re-use whole constructions in later projects, so why not make a library out of them that can be easily pasted in one go? In fact, why not make it really easy to grab U-value constructions from any PHPP that's open? The U-value library does just that (and can include the effect of wall ties for retrofits, and variant options too.)

The window tool, meanwhile, essentially allows complex windows to be defined by just four numbers. Now it has been extended so that it also writes all the main parts of the shading calculation too. This just means a few more options to the right of the dialogue. It also allows dimensions to be in mm or m, it will automatically detect which. A particularly neat feature is it writes figures as formulas, so you can change the dimensions of the window without having to redo the calculation.

Clients love bright houses, but there can be a tendency to overdo the window-sizing when it's not actually needed. Clients also don't always think about the energy consequences of large windows. Generally, a good window will have a U-value about five times worse than a good wall, so the knock-on effect of windows that are all bigger than they have to be is expensive windows and more insulation to compensate.

That's why daylight factor calculations are really useful, they allow the designer to check, and adjust if necessary. Mark Siddall has put a great deal of time into perfecting his daylight factor tool, a separate spreadsheet largely written using a button on the toolbar. It works to the relevant British Standard. Once results have been calculated these can be used to adjust the original window sizes. If windows have been put in with the window tool, then changing the dimensions of windows automatically adjusts all the shading figures (they are formulas) without having to redo them.

Within the AECB there is interest in keeping embodied CO2 low, if possible, through the choice of materials. Calculations were done for three standard house types for the AECB Carbonlite retrofit course. Very similar calculations can now be easily done for any PHPP with a new button and corresponding materials library. In fact, the calculation can go much further than the original AECB ones. It now includes all parts of the construction, PV panels, pipes, ducting, cabling (not generally significant) and plumbing fixtures, yet can still be done in around 20 minutes.

The passive house community is frequently open to sharing project information. It helps our sector grow, and it could save you time in your next project. The libraries of k-values, costs of items for retrofits (optional) and embodied carbon can be shared with other users through a central Google docs page set up for PHribbon users. Users can copy parts of their lists to the Google doc. Likewise other users can copy and paste into their own versions.

As before, affordability is still a main concern, and therefore the software is modular. The basic new build tools are £45, and various options can be bought as modules as needed.

Further information is available at **www.optimalretrofit.co.uk/phribbon/** ■

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